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Director's Biennial Report—1928-1930

September, 1930

Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

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TO THE PRESIDENT OF THE COLLEGE

Sir:

I have the honor to submit herewith the report of the Agricultural Experiment Station of Oregon State Agricultural College for the biennium ending June 30, 1930. The report includes a brief summary of progress and results of Station activities, presented by projects and departments. It contains a brief account of cooperation; it requests additional investigations and directs attention to certain urgent needs of the Station.

J. T. JARDINE,
Director.

September, 1930.

Director's Biennial Report

OREGON AGRICULTURAL EXPERIMENT STATION

1928-1930

September, 1930

FOLLOWING is a brief statement of the activities, progress, and accomplishments of the Agricultural Experiment Station for the biennium ending June 30, 1930. The report is presented in form and design similar to the reports of the past ten years in order to give a continuing and uniform record for reference.

The current biennium may be characterized as outstanding in the life of the Station, in that the Station has undertaken a greater volume of work and has received a heavier demand for services than for any other similar period of its existence. This expansion in activities was made possible by increased cooperation from Federal departments; by deferring the reprinting of bulletins still in great demand; by discontinuing Station exhibits at fairs; and by staff cooperation and effort, rather than by increase in state appropriations. State funds made available by the State Legislature in 1929, in fact, were $13,000 less for Station work during the biennium than were made available for 1926-1928. The urgency of the need for additional funds to control insect pests and undertake ground-water surveys was such, however, that on April 4, 1930, the Emergency Board granted additional funds amounting to $11,000.

The heavier demands on the Station for facts, for service, and for new investigations were due to the increased problems in crop production and crop protection from diseases and insect pests, and problems in marketing and economics. These demands for worthy investigations were far in excess of the available funds, and consequently many important research problems could not be undertaken.

STATE AND FEDERAL SUPPORT FOR RESEARCH

THE State Legislature in its 1929 sessions reduced the state support of the Home Station by $5,000 for the biennium 1929-1930, and discontinued a special appropriation of $8,000 for the Burns Station. The Emergency Board, however, as indicated above, granted an additional $11,000 April 4, 1930, including $8,450 for control of cherry fruit-fly and investigations of two new insect pests and $2,550 for cooperation with the U. S. Geological Survey, the people of The Dalles and Harney county to begin a survey of ground water available for pumping to irrigate cherries in The Dalles and general crops in the Harney Valley.

The Federal Purnell Act, approved in 1925, reached its ultimate maximum appropriation of $60,000 per annum, beginning July 1, 1929. While

this Federal increase exceeded somewhat the decrease in state funds for the Corvallis Station, it did not wholly offset the decrease, because the Federal fund is restricted in use.

The reduction in appropriation necessitated retrenchment in some lines of research, but budgets were adjusted to maintain most of the cooperative and state projects under way to the end of the biennium. The cooperative project with the United States Dairy Bureau was discontinued in June, 1929, losing to the state $2,500 of Federal assistance but releasing $2,500 of state funds for the maintenance of other important projects.

COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE

EFFECTIVE organization of state and federal resources was made to continue joint research on problems of Oregon. For the most part federal cooperation already established was continued and a limited amount of new cooperation was obtained. Such joint attack on problems made possible by this cooperation brings to the state a more vigorous and thorough investigation than can ordinarily be financed by the state alone, and by the joint effort the federal work is supplemented by the support of such Station departments and branch stations as may be of service for comprehensive investigation.

COOPERATION CONTINUED

The following investigations in cooperation with the different bureaus, United States Department of Agriculture, were continued:

Bureau of plant industry—

1. Investigations of forage crops in cooperation with the Office of Forage Crops Investigations.

2. Potato disease investigations in cooperation with Office of Cotton, Truck, and Forage Crops Diseases.

3. Bulb and ornamental disease investigations and "curly top" diseases of vegetables in cooperation with Office of Cotton, Truck, and Forage Crops Diseases.

4. The campaign to control white pine blister rust was continued with the Federal Office of Pine Blister Rust Control.

5. The Federal Seed Laboratory continued its office at Corvallis.

6. The strawberry breeding investigations in cooperation with the Office of Horticultural Crops and Diseases were continued and somewhat expanded.

7. Investigations into the possibility of growing perfume roses were continued in cooperation with the Office of Drugs, Poisonous and Oil Plants.

8. Cooperation was resumed with the Office of Fiber Flax Investigations.

9. The Moro Branch Station was continued in cooperation with the Office of Cereal Investigations.

10. The Umatilla Branch Station, Hermiston, was continued in cooperation with the Office of Western Irrigation Agriculture Investigations.

11. Investigations of perennial apple canker and related diseases were continued, the Office of Horticultural Crops and Diseases and the Hood River Branch Station cooperating.

12. The Pendleton Field Station was established in 1928 through the cooperation of the Office of Dry Land Agriculture, Bureau of Plant Industry, the Oregon Agricultural Experiment Station, and Umatilla county. The county furnished 100 acres of land valued at $200 an acre. The federal government is providing approximately $10,000 annually for maintenance and operation. The state is providing part of the maintenance. Improvements thus far are being provided mainly from receipts.

Other Federal bureaus—

13. The soil survey work in cooperation with the Bureau of Soils was continued.

14. Cooperation in the study of methods of irrigation and drainage, and in making economic surveys of irrigation projects, was continued with the Division of Agricultural Engineering, Bureau of Public Roads. The problems of drainage and supplemental irrigation in the Baker Valley, drainage and flood control in the Coquille Valley, and preliminary observations of drainage and irrigation in the Rogue River pear district were given special attention. A Federal Junior Engineer was assigned to the Rogue River Valley study July 22, 1929. Demand for work along these lines is far in excess of man power and funds.

15. Cooperation with the Bureau of Dairy Industry was started June 1, 1928, on investigations of butter standardization and was continued one year until the original study was completed. One technical man paid jointly by the cooperating parties devoted a year to this project.

16. The investigation of the ground-water supply in the Willamette Valley was started July 1, 1928, in cooperation with the United States Geological Survey. The cooperation is being continued through the biennium on ground-water studies in The Dalles region and Harney Valley.

17. The Insecticide and Fungicide Board of the Department of Agriculture continued one man at Corvallis for testing insecticides and fungicides.

NEW COOPERATION

The following new federal cooperation was obtained during the biennium.

1. The Office of Cereal Investigations, Bureau of Plant Industry, assigned a man to the study of "foot rot of wheat" in Eastern Oregon. This work will be coordinated with studies along production and economic lines at the Moro and Union stations. During the winter the Federal pathologist made his headquarters at the Corvallis Station, where the facilities of the Station were available for his work.

2. The entomological phases of "curly top" disease were studied cooperatively by the Bureau of Entomology and the Station through the temporary appointment of a Federal assistant. This cooperation was discontinued before the close of the fiscal year 1928-29, and beginning July 1, 1929, the Bureau of Entomology assigned a full-time man with field headquarters at the Hermiston Branch Station to work primarily on leaf-hopper survey. Facilities of the Hermiston Station were supplied and the federal employee contributed some cooperation to the "curly top" project investigations at Hermiston.

3. Investigation of nut production and nut disease problems was started in cooperation with the Bureau of Plant Industry, Office of Horticultural Crops and Diseases, in the fall of 1929. The Federal bureau finances the work for the most part except plant facilities and such cooperation as departments of the Experiment Station can contribute.

4. The strawberry and small fruit studies were expanded in cooperation with the Office of Horticultural Crops and Diseases, Bureau of Plant Industry.

5. Beginning July 1, 1929, the Bureau of Animal Industry entered into cooperation with the Department of Veterinary Medicine of the Experiment Station for further study of certain phases of infectious abortion in dairy cattle.

6. Dr. C. Dwight Marsh, of the Bureau of Plant Industry, cooperated in the diagnosis of an unidentified plant poisoning problem, which caused heavy losses of cattle in Eastern Oregon.

7. In July, 1930, the Federal Bureau of Entomology, Office of Stored Insect Products, arranged to assign one investigator to Corvallis for investigations looking to the control of pea-weevils.

8. In August, 1930, the Bureau of Plant Industry entered into cooperation for preliminary studies of hop mildew, which became a real problem of the hop industry for the first time in 1930.

9. In July, 1930, the Office of Cereal Investigations, Bureau of Plant Industry entered into further cooperation by assigning a junior agronomist for cereal investigations at the Pendleton Field Station.

In addition to the foregoing, the Station entomologist cooperated during 1929 with Federal entomologists and local people in the Rogue River Valley diagnosing and formulating plans for control of alfalfa weevil, which appeared in that section for the first time. A small Federal appropriation was granted to provide for this work beginning July 1, 1930.

Also, during 1929, a Station entomologist devoted considerable time to further observations, consultation, and informal cooperation with the representatives of the Bureau of Entomology concerning control of mosquitoes. A Federal fund was granted for the Bureau of Entomology to undertake research on this problem beginning July 1, 1930.

COOPERATION WITH THE OREGON STATE COMMITTEE ON RELATION OF ELECTRICITY TO AGRICULTURE

COOPERATION was continued with the Oregon State Committee on Relation of Electricity to Agriculture in investigations dealing with the use of electricity in agriculture. The Committee contributed $6,000 each year of the biennium to support the investigations. Equipment companies gave liberal cooperation to the Committee through the use of field and laboratory equipment and farmers cooperated in the field investigations. The Director of the Station remained Chairman of the Committee.

The following research problems were undertaken by the Committee:

1. Milk and cream refrigeration on the farm.
2. Electric hay hoisting.
3. Electric brooding of chicks.
4. Electric feed grinding.
5. Electric farm refrigeration.
6. Electric sterilization.
7. Electric water heating.
8. Electric silo filling.

COOPERATIVE FUND FOR IRRIGATION WELLS AND PUMPING

A GROUP of interested business men and organizations contributed a revolving fund of $6,000 in the fall of 1929 to make possible a test by the Agricultural Experiment Station as to the practicability of establishing wells from which water might be pumped by modern equipment for irrigation in the Willamette Valley. Agreement was entered into with Sam H. Brown of Gervais, Oregon, a berry grower, whereby Mr. Brown agreed to take over such a well fully equipped at cost of replacement provided the well proved to furnish a flow of water adequate for irrigation.

The first well developed under this revolving fund was established on Mr. Brown's farm early in 1930. It is an 18-inch stovepipe-casing type of well, 155 feet deep and provided with the most modern deep well equipment operated by electricity.

Throughout the summer of 1930, the well has developed approximately 1,000 gallons per minute when in operation. Mr. Brown installed an underground system for distribution of water to 35 acres of evergreen blackberries and a water distribution system was put in for approximately 15 acres of loganberries and about 10 acres of cucumbers. This entire acreage has been under irrigation during the cropping season of 1930. Harvesting is not completed, but advanced observations show that results are promising for future development of irrigation for intensive cropping in the Willamette Valley.

COOPERATION WITH STATE, COUNTY, AND CITY AGENCIES

THE Experiment Station, as the state agency responsible for research in agriculture in all its phases, continued to render close cooperation and assistance to other agencies requesting such service.

The following harmonious and helpful cooperation was rendered:

1. At the request of the State Irrigation Securities Commission, the Station, in cooperation with the Division of Agricultural Engineering, Bureau of Public Roads, made economic and feasibility surveys of the following irrigation districts: Owyhee, Tumalo, Silver Lake, Summer Lake, Payette, Lone Pine, Hermiston, and Scappoose.

2. Cooperation was given the State Dairy and Food Commission in the problem of removing spray residue from fruit.

3. The State Dairy and Food Commissioner received the cooperation of the Station Department of Bacteriology in the study of market milk supply of towns in Oregon.

4. Technical advice, information, assistance, and cooperation were given the State Horticultural and Plant Quarantine Board and the State Livestock Sanitary Board by members of the Station staff.

5. At the request of the Oregon State Fish and Game Commission, the Experiment Station assisted in a cooperative study of the economic status of the China pheasant in Oregon. The study was largely financed by the Fish and Game Commission.

6. At the request of the Portland Public Dock Commission, a survey and preliminary investigation was made of the invasion of grain weevils into flour stored in and handled through the Dock.

7. At the request of the Portland Chamber of Commerce a program for temporary control and investigation of the mosquito was outlined. The results of the operation of this program this year were satisfactory.

8. At the request of the City of Portland the operation of the Earwig Insectary was taken over by the Oregon Agricultural Experiment Station in June, 1930. The cost of this work will be financed by the city.

SOME OUTSTANDING ACCOMPLISHMENTS OF THE BIENNIUM

IT IS impracticable in this space to record the detailed results of approximately 400 Station projects under way during the biennium. Instead, only brief statements will be made of some of the outstanding accomplishments which are indicative of the progress and results obtained. Further detail of the work and results by projects is given in the fifteen departmental reports and in the eight branch station reports appearing elsewhere in this bulletin.

Results of investigations which show accomplishments of especial importance during the biennium are indicated as follows:

Austrian winter field peas. The promise of real value of Austrian winter field peas introduced and selected in connection with forage crop investigations during the previous biennium has materialized. The results from this crop during the present biennium indicate further that this is an outstanding new legume rapidly becoming established and meeting an important need for local consumption as well as for sale outside of the state.

The chief weaknesses of this crop are its susceptibility to aphids and to the attack of pea-weevil. The latter requires prompt threshing and immediate fumigation thereafter. In 1930 approximately 6,000 acres are being harvested for seed.

New wheat varieties. The two new wheat varieties, Oro and Regal, distributed from the Moro Branch Station continue to show promise when produced under field conditions. Oro has proved resistant to all forms of smut except one and has proved to be a superior wheat in both quality and yield. Regal has proved resistant to the common type of smut in the Northwest but was found susceptible to other forms.

A new hybrid named Arco was distributed in limited quantities in the fall of 1928. This hybrid shows special promise with characters of Federation but more winter hardy.

Separating prunes into quality grades. Experiments continued during the biennium have developed a process of separating both fresh and dried prunes into grades showing varying degrees of maturity and quality. The process is a flotation system employing heavy-density sirup where dried prunes are to be separated, and using a solution of salt brine of densities ranging from 30° to 60° Salometer when fresh fruit is to be separated.

This system can be used to determine the maturity of the fruit as well as actually separating the fruit into grades showing varying degrees of quality. It is recommended to prune growers for the purpose of separating the green fruit from the ripe fruit before dehydrating. This separation will improve the quality of the resulting dried product, speed up drier operations, and not increase cost of handling above that now obtained in the usual method employed for dipping the fruit.

Both the process and the machine designed for separating the fruit have been covered by public service patent assigned to the public.

Spray residue removal. The fruit spray residue problem continued to be of major importance during the biennium. Tests were made of six varieties of apples and seven commercial washing-machines of various types to determine the effect of washing on the keeping quality of apples. The results of these tests indicate that the commercial types of washing-machines using hydrochloric acid are generally satisfactory so far as injury to the fruit is concerned.

As an outgrowth of the spray residue problem, calyx injury in apples which has caused serious losses in past years was definitely shown as an arsenical trouble which can largely be prevented by the following precautions: (1) Keep the fruit dry after packing, (2) do not delay harvesting

operations, (3) use lime or bordeaux mixture in late sprays, (4) wash as soon as possible, (5) use lime in the rinse bath.

A new and improved home-made washer was designed and is described in Oregon Station Circular 92.

Immunization against coccidiosis in poultry. During the biennium coccidiosis investigations have been directed chiefly toward the determination of species and the problem of immunity. This investigation has resulted in the recognition of six species of coccidia, two of which are new. Five species have been produced in pure culture. These will be used in connection with future investigations in an effort to establish more specific methods of control which can be applied on poultry farms throughout the state.

The determination of these species is of outstanding importance because it lays the foundation for the establishment of more specific methods of control. The previous work on immunization which was recorded in the last biennial report has been continued and extended.

Control measures for infectious abortion in dairy cattle. Infectious abortion, which according to reliable estimates has for years been costing dairymen of the state between one million and two million dollars through the loss of calves, attendant sterility, decrease in milk flow, and secondary diseases, presents one of the most serious livestock problems in the state. For ten years the departments of Veterinary Medicine and Dairy Husbandry have been studying this problem in an effort to develop methods of control. In these investigations such progress has been made that the State Live Stock Sanitary Board has evolved a plan for accrediting dairy herds based on the application of Experiment Station recommendations.

The results of these investigations indicate:

1. The disease is not self-eliminating under usual dairy management conditions.

2. The agglutination test is a satisfactory method of diagnosis.

3. Reacting cows and heifers do not usually change to non-reactors; reacting calves do change to negatives.

4. The only satisfactory methods of control have been based upon the principle of preventing exposure of susceptible cows and heifers to infected animals.

5. Dairymen have found it practicable to control and eradicate the disease through testing their herds and protecting the disease-free animals from exposure.

6. The time necessary to establish a clean herd from an infected herd has varied from less than twelve months to three years.

7. Herds have been kept free from the disease through preventing exposure.

Improved method of vaccinating young fowls against chicken-pox. Further investigation of fowl-pox has resulted in the development of the stick method of vaccination which has proved highly successful in preventing one of the outstanding diseases encountered by the specialized poultryman. This stick method of vaccination was recommended to the poultry

industry in 1929 and during the summer and fall of that year more than 92,000 fowls were vaccinated by this method. It is estimated that approximately 150,000 fowls will be vaccinated in 1930.

Liver-flukes in sheep and goats. The discovery of snail hosts for the liver-fluke is a notable accomplishment of much value to the sheep industry in the state. Liver-flukes are responsible for serious losses in sheep and goats in all parts of the state. In August, 1928, specimens of *Galba bulimoides* were found which were carrying liver-fluke rediae and cercariae. In May, 1930, *Galba ferruginiae* was added to the list of molluskan host of this parasite. *Lymnada (Galba) bulimoides* Lea was the first definitely determined host for *Fasciola hepatica* on the North American continent. These were found to be widespread throughout Oregon even at very high elevations. It was found that snails lived at 37° F. for a month without food when water was provided. Cercariae are capable of living in the snails and being discharged for more than six months from date of infestation. Individual snails are capable of living with large numbers of cercariae in them, 580 having been discharged from one specimen.

A treatment of carbon tetrachloride in 1-c.c. doses destroyed mature and nearly mature flukes in livers of sheep and goats. The snails were destroyed by use of copper sulfate broadcast on the habitat. The destruction of snails, however, did not prevent their reappearance on the same pastures the following year. It was found that copper sulfate broadcast in twice the amount necessary to kill snails was not poisonous to the sheep.

Marketing lambs. Investigations of the problem of marketing lambs from Western Oregon indicate that losses approximating $140,000 per year can be eliminated by marketing lambs at the right time and in proper condition. The percentage of top lambs from Western Oregon on the Portland market is now 33 percent, but according to the investigations this can be raised to 80 percent. In the study it was found that Western Oregon lambs top the market in May and June and few lambs were good enough to top the market after July 1. It was found that lambs weighing from 60 to 80 pounds brought the top price if fat, and that milk-fat lambs at Easter time usually command a fancy price. The study indicated that thin lambs or lambs that were too heavy brought a much lower price than lambs of desirable weight and condition.

A promising new strawberry. As a result of tests of several thousand strawberry seedlings, one has been found which gives promise of proving satisfactory. It is a good canning berry for fresh market, the size, color and quality creating a demand.

Discovery of new hosts and methods of transmitting virus diseases of potatoes. Experiments conducted in cooperation with the U. S. Bureau of Plant Industry proved that Jimson weed, black nightingale, and wild bitter sweet, as well as tomatoes and peppers, can harbor the virus of potato leaf roll, while black nightingale and tomato can carry the rugose mosaic of the potato.

The most common species of aphid found in potato fields (*Illinoia solanisolii*) appears to transmit leaf roll with difficulty, while three other species of

aphid which are apparently not common in Oregon potato fields readily transmit the disease.

The discovery of these new sources of virus and agencies of transmission are important in control practices.

Perennial apple canker. The establishment of the fact that the woolly aphis is definitely associated with the spread of the perennial canker is an accomplishment of the Hood River Station, reported in Station Bulletin 243. Investigations conducted by the Station showed that not a single infection developed from pruning wounds and canker calluses on which aphis did not feed, whereas 90 percent canker infection followed where the aphis came in contact with pruning wounds and canker calluses. The establishment of this relationship between the spread of perennial canker and the woolly aphis is important in the development of control methods of the canker.

Complete control was obtained by the use of nicotine sulfate added to paints at the rate of one part of nicotine sulfate to four and six parts of paints. Paints tested were various combinations of tanglefoot diluted with equal parts of gasoline and carbon tetrachloride to a point where the material could be applied with a brush and the Hood River tree paint, a rosin-fish-oil-bordeaux combination. Where these combinations were used without the nicotine, noticeable aphis infestation developed late in the season.

Pollination study of the Anjou pear in Hood River Valley. As a result of the study of Anjou pear pollination at the Hood River Station the Anjou pear has been transformed from a light irregular bearer in many orchards in the Hood River Valley to a consistently heavy yielder. The results of this study are being generally employed by growers in making new plantings of pears and the pollinators have been topworked in old bearing orchards. When the pollinators now planted in the district reach the age where they will produce heavy blooms, it is safe to say that average production of Anjou pears will be increased at least 50 percent and probably more.

"Curly top" of vegetables. The testing of 843 varieties of vegetables and other plants for resistance to the "curly top" disease of vegetables has resulted in the discovery of a bean and a squash plant which appear to be fairly resistant. The bean is a commercial variety which has been grown in Central Oregon for a number of years and apparently has acquired resistance through more or less natural selection. The resistant squash is a strain which has been grown in the Hermiston district for a number of years, is of fair quality as a table squash and on account of large yields is valuable as a stock squash.

This investigation in cooperation with the Bureau of Plant Industry and the Hermiston Branch Station is a result of the identification of the "curly top virus" as a serious vegetable disease, by Professor McKay in 1926.

Development of bran bait for strawberry root weevil. The development of a bran bait that can be made up by the growers and used effectively for the control of the native strawberry root weevil (*Dyslobus edcorata*

Lec.), as well as for the common strawberry root weevil (*Brachyrhinus*) gives promise as a satisfactory control for these pests. In the past it has been difficult to control these weevils due to heavy rains early in the spring. The excellent control obtained in the 1930 season with this bran bait and sodium fluosilicate is encouraging. Further work will be done to substantiate the results secured during the past season. A distinct advantage of this bait is that it is inexpensive and can be easily made by the growers.

Control for narcissus bulb fly encouraging. Experiments with sprays for the control of the narcissus bulb fly gave 100 percent control when bordeaux oil emulsion was used in the 1930 season. This method of control appears to be more valuable than the old method, which consists of fumigation and hot water sterilization, in that the spray method kills the fly before any injury to the bulb is made whereas the fumigation method kills the insect after the injury is done.

Discovery of new forms of smut. The discovery of a number of physiologic forms of smut is an outstanding accomplishment from the standpoint of the plant breeder, enabling him to classify the various forms of smut and the resistance of varieties to them. The chief advantage to grain growers as a result of this discovery is in the additional opportunity it offers for the development of varieties more resistant to the disease.

In 1928 the Central Station and the Moro Branch Station cooperated in a rather elaborate collection of smuts from many different sources and made smut inoculation tests with many wheats formerly considered resistant or immune. The results indicate that there are at least six distinct physiological forms of smut, each reacting in a different manner on wheat varieties tested.

Enterprise cost and efficiency study. The conclusion of six different major enterprise cost and efficiency studies, which determined (a) cost of production, (b) comparative costs and profits, and (c) methods of reducing the cost in six major farm enterprises, is a worthy contribution in farm management investigations. These studies cover the major enterprises of thousands of farmers, and point the way to the development of more improved practices and larger incomes. In these investigations the Station is presenting to the farmers the same character of information and advice as the consulting engineer or the industrial efficiency expert gives to his constituents.

These investigations will be continued with five new enterprise studies now under way.

Fresh fruit disinfection. Experiments conducted during the biennium have resulted in the development of promising methods of rapid surface disinfecting of fresh fruits which should aid in reducing losses to shippers of fresh cherries from Western Oregon to the East. Reduction of losses from the decay of ripe prunes while awaiting admission to congested driers may also be realized. Under laboratory tests the decay in cherries was reduced from 66 percent of rot to 17 percent. Other tests of cherries held in common storage for five to six days showed a reduction of decay from 51 percent to 12 percent.

Basal canker of red raspberry. The diagnosis of an unknown disease which has caused an estimated annual loss of $75,000 to Oregon raspberry growers has been worked out during the biennium. Two parasite fungi, the yellow rust and the cane blight organism, are jointly responsible for this disease. This information makes possible an intelligent attack upon problems of control.

Time of picking and storage life of pears. Determining the proper time of picking and the correct storage life of all commercial varieties of pears is an accomplishment worth thousands of dollars to pear growers. Investigations conducted jointly by the Central Station and the Southern Oregon Branch Station indicate that picking the pears at the proper time improves the quality, lengthens the storage season, and prevents core breakdown in storage. By use of the pressure tester developed by the Oregon Agricultural Experiment Station, growers can now ascertain when each variety should be picked and just how long it can be kept in storage.

Walnut blight control. The annual crop reduction from bacterial blight of walnuts has averaged not less than 25 percent, rising much higher in some years and causing as high as 60 percent to 70 percent crop loss in individual orchards in certain seasons. Tests made by the Experiment Station indicate that substantial reduction in blight losses can be brought about by properly timed sprays. For example, blight was reduced from 40 percent to 8 percent of the crop by a single application of bordeaux mixture in one grove in 1929. In another grove 12 percent loss was reduced to .5 percent loss by two applications. While these results are encouraging, some spray injury resulted and general adoption of spraying cannot be advised until the factors responsible for such injury are determined and a way of avoidance worked out.

Dairy calf meal. The development of a calf meal, which makes it possible to raise calves without milk after they are from 30 to 50 days of age, is of especial interest to those sections of the state selling whole milk. The Station has demonstrated that thrifty calves can be grown with the dry calf meal at a cost less than when skim milk is used. It is estimated that a saving of $2.00 a month can be made during the first six months of the life of the calf, which means a saving of $12.00 as compared with the cost of raising calves on skim milk. This saving is greater where the calf meal is used to replace whole milk. The results are so satisfactory that a large number of feed manufacturers are using the Station formula in manufacturing their own calf meal. These results are fully described in Circular of Information 25 (revised).

Irrigated pastures. The development of irrigated Ladino clover pasture, which gave a net return of $46 per acre when pastured with dairy cows, is a significant accomplishment of the biennium. This result points out (a) the possibilities of profitable irrigation in those sections of the state not now using irrigation, and (b) the possibilities of more profitable utilization of land in the irrigated sections east of the mountains.

Irrigation of small fruits. Outstanding increases in size, quality and yield of small fruits have been obtained as a result of supplemental irriga-

tion. In 1929 the percentage of increase in yield of berries was as follows:

	percent
Marshall strawberries	67.9
Loganberries	88.0
Red raspberries	88.8
Black raspberries	57.0
Evergreen blackberries	144.0

These yields were due largely to an increase in bearing surface, an increase in the size of the berries, and to the greater number of berries.

As a result of irrigation it was possible in 1927 to set a new field of strawberry plants after an early crop had been harvested, the planting being done August 15. Of the varieties tried, O. S. C. No. 12 gave the best results, yielding at the rate of 5,200 pounds per acre in 1928, while a second planting, made August 1, 1928, produced 6,000 pounds per acre in 1929. With Ettersburg 121 strawberry, however, there was a decrease of 9.3 percent. Irrigation has not paid with this variety.

A new root crop introduced. The introduction of the Bortfeld turnip as a result of tests conducted by the John Jacob Astor Branch Station, Astoria, is an accomplishment of great value to dairymen in the Coast section. This variety of root crop combines nearly all of the desirable characteristics of root crops, including: 1. Ease in harvesting. 2. Good keeping quality. 3. Resistance to root maggots. 4. High yields.

According to the Station tests this crop can be produced at a cost of about 40 percent less per ton than any other desirable variety of rutabagas. It is felt as a result of these tests that there will be a great increase in the acreage of root crops grown in the Coast section.

Soil survey. The foundation was laid for an intelligent program of land utilization by a soil survey of 1,000,000 acres in Marion and Columbia counties. The Umatilla soil survey was initiated.

Well irrigation in the Willamette Valley. The insurance of crop production by means of supplemental irrigation from deep wells has been determined a feasible, economical, and practical possibility. Following the taking of an invoice of the ground-water resources of the Willamette Valley through a cooperative ground-water survey, an experimental well 18 inches in diameter and 155 feet deep was drilled on a fruit farm. This well developed a flow under continuous pumping of slightly more than 2 cubic feet per second, or sufficient water to irrigate 160 to 200 acres of land. This experiment and demonstration were made possible through a revolving fund provided by interested business men and by an enterprising berry grower who had the courage to join in the work and agree to take over the well at replacement cost. (See cooperative fund for irrigation wells and pumping, p. 11.)

Approximately one-half million acres of farm land in the Willamette Valley is suitable for supplemental irrigation and offers the opportunity of doubling the present productive value of this land.

Establishing the value of lime in Coast sections. After many years of tests at the Astoria Branch Experiment Station, lime has been determined

as the most necessary of all fertilizers to maintain the fertility of new soils and to build up the fertility of soils which have been depleted. It is useless to attempt to introduce legumes without first adding lime to the soil, as the tests indicate that the lime is the basis upon which all permanent fertility is to be built in the Coast section.

PUBLICATIONS

THIRTY-TWO Station Bulletins, 12 Station Circulars, and 14 Circulars of Information were prepared and published during the biennium. In addition to these publications, issued directly by the Station, more than 70 articles, technical in character and recording results of experimental projects, were printed in national and regional scientific and farm journals. Through the use of scientific journals the results of research are made available to research workers and the limited funds of the Station are thus reserved for Station publications of interest primarily to the general public. It would be desirable, of course, to have more of this information printed in technical Station bulletins, but the funds that can be made available are insufficient to finance the more popular material of immediate use to agriculture in a practical way.

Because of limited funds editions of Station publications are small, ranging from 3,000 to 8,000 copies, and as a result of increased demands from county agricultural agents and farmers new publications are usually exhausted within a short time.

The Station does not maintain an individual mailing list, but distributes copies of publications only on request. This policy insures advantageous use of publications and permits the printing of a greater number of different bulletins than would otherwise be practicable with limited funds.

Reprints needed. The Station has now issued a total of 268 bulletins and 96 circulars and frequent calls are received for some of these publications which are out of print. Obviously a continuing supply of the 365 publications cannot be maintained by reprints financed out of funds provided for specific investigations to solve new problems. Some provision should be made for reprints of publications which are in considerable demand, such as the following:

Circulars—

Number	*Title*
32	Strawberries.
43	Grape Growing in Oregon.
44	Crop Rotation and Soil Fertility.
50	Control of the Western Peach and Prune Root-Borer.
51	Building Plans and Bill of Materials for O. A. C. 400-Hen Laying House.
54	Open Air Range House.
56	Cost of Producing Pork.
65	Insect Pests of Truck and Garden Crops.
66	Building Plans and Bill of Materials for O. A. C. Portable Brooder House.

67 Field Production of Ettersburg 121 Strawberry.
75 Studies Relating to the Harvesting of Italian Prunes for Canning and Fresh Fruit Shipment.
84 Chemical Composition of Insecticides and Fungicides.

Bulletins—

Number *Title*

150 Dry Farming Investigations at the Harney Branch Station.
182 Growing Steers.
184 Silage for Fattening Lambs.
195 Stump Land Reclamation in Oregon.
201 The Preparation of Spray Materials.
231 Electric Lights for Increasing Egg Production.

Publications issued. The following publications were issued during the biennium:

Bulletins—

Number	*Title*	*Edition*	*Pages*
237	Liming Western Oregon Soils	5,000	20
238	Coccidiosis of the Chicken	8,000	16
239	Pollination Study of the Anjou Pear in the Hood River Valley	5,000	16
240	Soils of Willamette Series and Their Utilization	5,000	28
241	Cost and Efficiency in Producing Alfalfa Hay in Oregon	10,000	72
242	The Occurrence and Prevention of Calyx Injury in Apples from the Hood River Valley	10,000	24
243	The Relation of the Woolly Apple Aphis to Perennial Canker Infection with Other Notes on the Disease	8,000	32
244	Oregon Apple Prices	6,000	32
245	Cost and Practices in Strawberry Production in the Willamette Valley, Oregon	10,000	44
246	Alfalfa in Western Oregon	15,000	40
247	Investigations Relating to the Handling of Sweet Cherries with Special Reference to Chemical and Physiological Activities During Ripening	10,000	40
248	Cost and Efficiency in Producing Hay in the Willamette Valley	12,000	48
249	The Chemical Composition and Food Value of Oregon Dried Prunes	8,000	12
250	Cost of Horse Labor on Oregon Farms	8,000	20
251	Cost of Producing Silage and Kale in the Willamette Valley	10,000	36
252	Studies of Factors Influencing Separation of Dried Prunes into Quality Grades	10,000	48
253	Congenital Loco in Chicks	5,000	16
254	Further Investigations on the Harvesting, Storing, and Ripening of Pears from the Rogue River Valley	8,000	24
255	Electric Hay Hoists	8,000	16
256	Use of Time by Oregon Farm Homemakers	10,500	72
257	Trends of Tax Levies in Oregon with Emphasis upon Rural and City Real Problems	5,000	48
258	The Butter Industry of Oregon	2,500	32
259	Sprays, Their Preparation and Use	8,000	28
260	Marketing Willamette Valley Wools Through the Pacific Cooperative Wool Growers	3,000	16
261	Willamette Valley Wools in Relation to Local Consumption	3,000	24
262	Electric Brooders	8,000	24
263	The Market Situation and Outlook for the Oregon Canned Fresh Prune	8,000	32
264	Irrigated Pastures for Dairy Cattle	8,000	32
265	Lamb Marketing Investigations in Western Oregon	8,000	16
266	Studies in Fascioliasis in Oregon Sheep and Goats	5,000	24
267	Cost and Efficiency in Pear Production in the Rogue River Valley	8,000	56
268	Mechanical Refrigeration of Milk in Cans	10,000	28

Circulars—

Number	*Title*	*Edition*	*Pages*
35	Cherry Fruit-Fly (Reprinted)	5,000	4
86	The Wheat Jointworm in Oregon	3,000	8
87	Commercial Fertilizers	1,500	24
88	Motor-Driven Green Feed, Root, and Straw Choppers	5,000	8
89	The Jerusalem Artichoke	5,000	16
90	Meaning and Use of Willamette Soil Survey	5,000	20
91	English Walnut Production in Oregon	5,000	48
92	The Oregon Apple-washer	10,000	8
93	Scours in Oregon Sheep and Goats	10,000	16
94	Cost of Producing Sheep on Western Oregon Farms	7,000	32
95	The Chemical Composition of Insecticides and Fungicides	1,500	20
96	Potato Diseases in Oregon and Their Control	8,000	84

Circulars of Information—

Number	*Title*	*Pages*
22	Harvesting, Storing, and Ripening of Pears for Canning Purposes	5
23	Observations on the Harvesting and Handling of Apples from the Hood River Valley	5
24	The Pear Blister Mite, an Old Pest in a New Role	1
25	Raising Calves on Calf Meal	5
26	Hot Water Treatment of Narcissus Bulbs	3
27	Strawberry Crown-Moth in Oregon	2
28	Strawberry Root-Weevil Control in Oregon	2
29	The Status of Insecticides for Codling Moth Control in Oregon	2
30	Recommendations for Eradication of Nematodes from Narcissus	3
31	Questions and Answers About the Cherry Fruit Fly	2
32	Maraschino Cherries, Methods for Bleaching and Dyeing	6
33	Tentative Suggestions on the Control of Hop Downy Mildew	2
34	Oregon Insect Pest Report for May, 1930	4
35	Cost of Commercial Egg Production in Oregon Progress Report No. 3	19

SUMMARIES OF PUBLICATIONS

INDICATING the character of the research problems undertaken and illustrating some of the results of investigations, brief abstracts of publications which have been issued during the biennium are presented herewith.

STATION BULLETINS

237. **Liming Western Oregon Soils,** R. E. Stephenson and W. L. Powers.

In this bulletin are presented results of investigations relative to the liming of Western Oregon soils. Special treatment is given to the cause of soil acidity, the effects of soil acidity on crop production, methods of correcting soil acidity by the use of lime, and methods for applying lime to the land.

The bulletin covers experimental results of plots and farm trials of liming and of soil acidity surveys and studies conducted by the Station during the past fifteen years. In these studies it was found that soils of Western Oregon, and especially those of the Willamette Valley and Coast counties are acid and in need of liming. The use of lime on acid soils of humid regions, especially for legumes, is regarded as fundamentally sound. Lime makes soil sweet, improves tilth and water capacity for both growth

and desirable soil micro-organisms, renders more plant nutrients available and increases yields, especially of legumes.

238. **Coccidiosis of the Chicken,** W. T. Johnson.

In this bulletin results of investigations with coccidiosis, the most widely distributed disease-producing agent in Oregon's specialized poultry flocks, are discussed. The cause of the disease is described and the nature of the parasite causing the disease are discussed. The symptoms and diagnosis of the disease are explained and control methods are given special attention. In the experiment it was found that strict sanitation alone controls the disease. Applying strict sanitation depends upon the knowledge of the parasites and the nature of the disease. In addition to sanitation liberal milk feeding for a limited period is used to control severe outbreaks. In the study a small parasite distinguishable only under the microscope was established as the cause of coccidiosis. At least four different kinds of chicken coccidia are found in Oregon flocks and the severity of the disease is dependent upon the number of parasites consumed.

239. **Pollination Study of the Anjou Pear in Hood River Valley,** Gordon G. Brown and Leroy Childs.

Owing to the irregular bearing characteristics of the Anjou pear in the Hood River Valley, the Station undertook a study of factors relative to the pollination of the variety. This publication deals with the results of these studies and considers the work of cross pollination of the Anjou pear under Hood River Valley conditions. Under conditions of tests made in 1927 and 1928, self sterility of Anjou is demonstrated. The Bartlett, Easter, and Fall Butter were found to pollinate Anjou effectively. All three bloomed satisfactorily with Anjou. The first two are recommended because of their commercial value. Fertilization of Anjou pears was accomplished both in warm, favorable weather and during cold, rainy weather when pollen was artificially applied. It is apparent that failure of the variety to set in mature commercial plantings is due to the absence of pollen or because the pollen of crossing varieties is unable, owing to inclement weather, to reach the Anjou blossoms.

240. **Soils of Willamette Series and Their Utilization,** W. L. Powers, C. V. Ruzek, and R. E. Stephenson.

This bulletin records the results of investigations with soils of the Willamette Valley. Soils of the Willamette series occupy the gently rolling, naturally drained, brown colored land in the old Valley filling or Valley floor of the Willamette and include about one-third million acres. Four types of Willamette series have been mapped in the cooperative soil survey; namely, loam, silt loam, clay loam, and silty clay loam. Chemical analyses indicate that soils of the Willamette series are comparatively strong soils and well supplied with essential nutrients such as potassium and sulfur. There is a marked variation in the amount of calcium contained, which may partly account for difference in response to lime reported from different field tracts.

Liming has increased nitrate formation on Willamette silt loam. Crop rotation has given remarkable results in experiments maintained on Willamette silt loam for the past fifteen years, but fertilizer experiments show only moderate returns.

241. **Cost and Efficiency in Producing Alfalfa Hay in Oregon,** H. E. Selby.

The weighted average cost of producing alfalfa hay in the six principal alfalfa regions in the state for the three years 1925, 1926, and 1927, was $27.06 per acre or $7.96 per ton. This figure is based on 629 survey records covering 27,927 acres of alfalfa, with a production of 93,982 tons of hay.

A reduction of 8 percent in the average cost of producing alfalfa hay in Oregon would amount to a half million dollars annually. This study indicates that the principal factors that influence the cost of producing alfalfa hay, and that can be controlled to reduce cost, are (1) harvesting efficiency, (2) yield, and, (3) method of establishing the stand. Significant factors upon which data were obtained are discussed under these three main headings as follows:

Harvesting efficiency. The use of slips as compared with wagons; slings as compared with hay forks; the use of buckrakes; types of hay derricks and features of their construction, including a plan for a desirable type of derrick; effect of yield upon amount of labor required for harvesting; effect of length of haul; and effect of size and organization of the haying crew.

Yield. Relation of yield to cost; relation to yield of thickness of stand, age of stand, value of land, fertilization, cultivation, and size of acreage.

Method of establishing the stand. Seeding alfalfa with grain cost only $5.43 per acre as compared with $21.33 per acre for seeding alone. Under certain conditions, however, seeding alone is necessary.

Alfalfa comprised 90 percent of the hay acreage and 50 percent of the total crop acreage on the farms that were studied, and the type of farming followed was based to a large extent on alfalfa production. Three-fifths of the hay was fed by the growers, the remainder being sold.

The weighted average of the prices received was $10.03 per ton as compared with the average cost of $7.96, but as the capital investment averaged $156 per acre the percentage return on capital was not large, and an extensive acreage is necessary for a satisfactory income from alfalfa alone.

242. **The Occurrence and Prevention of Calyx Injury in Apples from the Hood River Valley,** Henry Hartman, Leroy Childs, and R. H. Robinson.

Calyx injury of the type found in the apples of the Pacific Northwest is primarily an arsenical trouble. It is found only in fruit that has been sprayed with arsenical compounds, and can be produced by introducing soluble arsenic into the calyces of unsprayed apples. It occurs only when apples sprayed with arsenicals become wet either before or after harvest. Calyx injury under Hood River conditions may be followed by decay from *Penicillium* (blue mold) or *Gloeosporium* (perennial canker). Occasionally it is followed by such organisms as *Alternaria* (black mold), *Botrytis* (gray mold), *Neofabraea* (anthracnose), *Glutinium* and *Frusarium.*

The present studies have shown that acid liberated by the apple itself may contribute to the solubility of arsenic compounds in the calyces of

apples. The following precautions were found effective in preventing calyx injury:

(1) Keep the fruit dry after harvest.
(2) Rush harvesting operations so as to reduce exposure to rain.
(3) Use lime or bordeaux mixture with the late summer sprays.
(4) Wash as soon after picking as possible.
(5) Change washing solutions frequently.

243. **The Relation of Woolly Apple Aphis to Perennial Canker Infection with Other Notes on the Disease,** Leroy Childs.

This bulletin reports the results of studies of perennial canker conducted in the Hood River Valley from 1925 to 1928, inclusive. In this study it was found that perennial canker is a wound parasite apparently incapable of entering sound, uninjured tissue. The canker is not truly perennial. New annual infections extend the cankers when conditions are favorable. The woolly aphis is definitely associated with canker infection, and canker infection usually follows severe late aphis infestation.

The extent of canker advance is to a large degree governed by winter temperatures. All pruning wounds are potential canker centers as practically all are eventually attacked by woolly aphis. Control methods are described.

244. **Oregon Apple Prices by Variety, Grade, and Size, 1922-1926,** R. S. Besse and M. R. Cooper.

Commercial apple production throughout the United States has been struggling in recent years against severe competition both of one region against another in the enterprise itself, and from an increasing supply of other fruit.

Detailed prices by variety, grade, size, year, and district were obtained from the book records of cooperative and independent shippers covering 9,607,119 boxes of graded and packed apples in the seven important apple districts of Oregon, from 1922 to 1926.

The Yellow Newtown and Esopus Spitzenburg were the most important varieties studied, comprising 51.4 percent and 23.5 percent, respectively, of the total.

The average price received by growers for apples packed and delivered at shipping point during the five-year period was $1.00 per box. The weighted average yearly price fluctuated from 76¢ to $1.46 per box. The price of different varieties ranged from 33¢ to $1.39 per box.

Of the apples studied, 35 percent were graded as "extra fancy" and brought the grower a weighted average price of $1.25 per box; 45 percent were graded "fancy,' and brought 95¢ per box; 16 percent were graded "choice" and averaged 69¢ per box. In general, the largest-size apples brought the highest average price. Of the eight leading varieties studied, 43 percent were of the larger sizes, 31 percent medium sizes, and 25 percent smaller sizes. The leading varieties exported were Yellow Newtown, Esopus Spitzenburg, Ortley, Jonathan, Arkansas Black, and Delicious.

245. **Costs and Practices in Strawberry Production in the Willamette Valley,** C. E. Schuster and A. S. Burrier.

This study, covering the crop of 633 acres of bearing strawberries, was designed to determine (1) cost of producing strawberries; (2) factors that

have a major influence on the cost and efficiency of strawberry production; (3) cost of establishing a planting of strawberries; (4) major factors affecting the cost and efficiency of establishing a strawberry planting, and (5) present internal organization of the strawberry farms and possible improvements that might be made.

The chief findings of this study were as follows:

1. The average production cost for the 1925 and 1926 crops on the farms included in the study was $191 per acre and $5.87 per pound of berries.

2. The cash or out-of-pocket cost was 2.9¢ per pound.

3. The average cost of 27 percent of the growers was 4.4¢ per pound, of 32 percent 5.6¢ per pound, of 31 percent 7¢ per pound, and of 10 percent 10.6¢ per pound.

4. Yield per acre and the efficient use of man labor are of major importance as factors accounting for variations in cost between growers.

5. The natural fertility of the soil, the use of varieties adapted to the particular soil type, proper and timely cultivation, and disease and pest control are of major importance in influencing the yield obtained. Timely cultivation also controls the efficiency of the labor used in caring for the planting.

6. Labor requirements for producing strawberries were found to vary widely, indicating that many growers could improve their efficiency in performing the various labor operations.

7. The average cost of establishing a strawberry planting was found to be $79.28 per acre. Of this cost, 58 percent was for labor and 22 percent was for plants. Cash or out-of-pocket cost was $33 per acre or 42 percent of the total cost.

8. Wide variations were found in the cost of establishing a planting. There is opportunity for cost reduction through (1) using less costly land, (2) setting larger patches that can be cared for more efficiently, and (3) performing the various labor operations in a more efficient manner.

9. Marked improvement in the general organization of many of the farms seemed possible. Factors that appeared most in need of adjustment were (1) diversity of business, (2) volume of business, (3) yield or quality of production, and (4) crop rotation.

246. **Alfalfa in Western Oregon,** H. A. Schoth and G. R. Hyslop.

Alfalfa promises to become the most important legume for forage production in Western Oregon and helps materially in reducing the present deficiency of legume forage. The Willamette Valley and Southern Oregon can and do grow good alfalfa successfully.

Full directions are given as to seed-bed preparation, kind of seed, time and method of seeding, handling new stands and cutting and curing the hay. Lime has been found to be necessary for the successful production of alfalfa on many Western Oregon soil types. Inoculation of the seed is necessary in establishing stands. Land-plaster or sulfur, applied early in March, increased yields and quality of hay. Pests of alfalfa are discussed. The best methods of handling and curing hay are given.

247. **Investigations Relating to the Handling of Sweet Cherries with Special Reference to Chemical and Physiological Activities During Ripening,** Henry Hartman and D. E. Bullis.

This bulletin covers five years of work on the handling of sweet cherries. While a great deal of the work was done at Corvallis with cherries from the Willamette Valley, a considerable amount of it was done at Hood River and The Dalles.

In spite of rather wide variations between seasons, sweet cherries undergo a marked increase in weight and size during the ripening period, and tonnage is materially affected by time of picking. The decrease in firmness that occurs during ripening of sweet cherries is less pronounced than that manifested by most deciduous fruits. The sugar and solid content of sweet cherries undergoes a material increase during the ripening period. This increase is closely correlated with maturity and quality. Although reduction is not always consistent, acidity decreases as maturity approaches. This is shown by the figures for total acidity as well as by those for hydrogen-ion concentration. As indicated by taste and by the tannin and coloring matter content, there is a decrease of astringency as the fruit ripens. Color, in the dark varieties of sweet cherries, is definitely correlated with maturity. Time of picking does not affect materially the shipping quality of sweet cherries. Aside from loss of weight and loss of volume, sweet cherries undergo no striking physiological or chemical changes immediately following removal from the tree. Time of picking has considerable influence on the quality and appearance of the canned product. Suggestions are given relative to the harvesting and handling of sweet cherries and a test of maturity based upon the sugar and solid content of the juice is given in detail.

248. **Cost and Efficiency in Producing Hay in the Willamette Valley,** H. E. Selby.

The average cost of producing hay in the Willamette Valley for the three years 1925, 1926 and 1927 was $7.08 a ton for clover hay, $9.87 for vetch-and-oats, $7.93 for alfalfa, and $9.93 for cheat. These figures are based on 484 farm-survey records covering 10,146 acres of hay with a production of 23,292 tons.

A reduction of 6 percent in the average cost of producing hay in the Willamette Valley would amount to more than a quarter of a million dollars annually. This study indicates that the principal factors that influence the cost and that can be controlled to reduce it are (1) harvesting efficiency, (2) yield, and (3) method of establishing a stand of clover. Significant factors upon which data were obtained are discussed under these three main headings as follows:

Harvesting efficiency. The use of side delivery rakes and hay loaders as compared with ordinary methods; the practices of mowing with tractors, chopping hay into the barn, and baling directly from the field, the use of slings as compared with forks; effect of yield upon amount of harvesting labor required; effect of length of haul, and of size and organization of haying crews.

Yield. Relation of yield to cost; relation to yield of value of land, kind of soil, fertilization, size of acreage, production of clover seed and life of

clover stand, variety of vetch, methods of soil preparation and date and rate of seeding vetch.

Method of establishing a stand of clover. The average cost of seeding clover with grain was only $2.60 per acre as compared with $15.65 for seeding alone—a difference in cost that will pay for a considerable amount of lime or fertilizer. For seeding with rape the cost was $12.35 per acre when the pasture was valued at prevailing rates.

The average return to the grower for hay that was sold was $9.70 per ton for clover and $11.62 for vetch-and-oats, as compared with the average costs of production of $7.08 and $9.87 respectively.

249. **The Chemical Composition and Food Value of Oregon Dried Prunes,** J. S. Jones and D. E. Bullis.

In the course of other investigations large numbers of chemical analyses of prunes were made. Averages of these analytical data are published in this bulletin.

For Italian prunes the composition is: pits 12.6 to 20 percent; moisture 16.4 to 20.3 percent; acid on dried flesh 2.4 to 3.4 percent; sugar on dried flesh 55.3 to 59 percent. For Petite prunes the values are: pits 11.6 to 16.6 percent; moisture 11.9 to 13.2 percent; acid on dried flesh 1.4 to 1.7 percent; and sugar on dried flesh 68.6 to 69.9 percent.

In dried prunes most of the sugar is present as fruit sugar and invert sugar. The acid is principally malic with some citric and tartaric and traces of benzoic and boric.

The mineral constituents are mentioned and a brief discussion of the food value and the place of prunes in the regular diet is included.

250. **Cost of Horse Labor on Oregon Farms,** H. E. Selby, B. W. Rodenwold, and H. D. Scudder.

This bulletin presents (1) costs of horse labor in 1926 in six important irrigated regions in Oregon; (2) costs of horse labor in the Willamette Valley in 1926; (3) costs of horse labor on Eastern Oregon dry-land wheat farms in 1921 and 1922; (4) costs of city horse labor, 1924 to 1928, for a representative city user of horses, and (5) costs of horse labor on the experiment farm and campus at Oregon State Agricultural College, 1916 to 1927. The study was based on a total of 4,693 horse-labor records.

The average cost of horse labor per horse-hour was found to be 9.9¢ in the irrigated regions; 13.0¢ in the Willamette Valley; 10.9¢ on the Eastern Oregon wheat farms; 21.4¢ for the city horses; and 15.1¢ on the College campus and Experiment Station farm.

The chief factor affecting the cost per horse-hour was the number of hours that the horse worked during the year, the cost being less for horses that worked more hours. Hence the biggest opportunity to reduce the cost of horse labor is to increase the amount of work per horse.

Other means of reducing horse-labor costs are by selling horses when they pass their prime and having colts to take their places, and by keeping the horses on pasture as much as possible not only to save hay and grain but also to reduce the amount of chore labor.

251. **Cost of Producing Silage and Kale in the Willamette Valley,** H. E. Selby.

The average cost of producing silage and kale in the Willamette Valley for the three years 1925, 1926, and 1927 was $7.40 per ton for corn silage, with an average yield of 5.7 tons per acre; $4.27 per ton for vetch silage, with a yield of 7.9 tons; and $3.78 per ton for kale, yielding 18.1 ton. These figures are based on 305 farm-survey records covering 2,506 acres producing 17,299 tons of silage and kale.

Some of the factors affecting the cost of silage and kale that this study indicates to be important and that can be controlled by the grower to reduce his costs, are as follows:

Yield. For all three crops the cost per ton was lower with higher yields.

Fertilization. The use of land-plaster on vetch and of manure on corn ground, was found to be profitable.

Rate of seeding. It was profitable to use plenty of seed for both corn and vetch.

Transplanting kale. Transplanting kale by hand required 25 hours of man labor per acre as compared with only 13.4 hours where plant-setting machines are used.

Cultivation. Corn growers who did more cultivating obtained better yields at lower costs per ton, although the amount of cultivation that is necessary depends, of course, upon the kind of land.

Harvesting. Significant factors upon which data were obtained are the practice of binding corn as compared with cutting by hand; the relation of size of crew to cost of filling silos; the effect of length of haul; comparative costs with owned and hired silo outfits; and the effect upon cost of amount of silage per farm.

252. **Studies of Factors Influencing Separation of Dried Prunes Into Quality Grades,** E. H. Wiegand and D. E. Bullis.

After four years of study of the factors involved in determining quality of the dried prunes, a method has been devised which will satisfactorily separate dried prunes into quality grades. The method makes use of the principle that dense bodies sink in solutions in which less dense bodies float. Thus heavy, dense, dried, or fresh prunes may be separated from the lighter ones by placing a mixture of the two kinds in sugar or salt solutions of the proper concentrations. The method, as well as a machine for accomplishing the separation automatically, has been protected by public service patent and is thus available to all interested.

The heavy, dense fruit is found to be higher in sugar, lower in acid, and to possess physical characteristics in the matter of color and texture of flesh that are indicative of superior quality. The light prunes contain less sugar, more acid, and generally they are coarser textured and not as well colored. The application of the flotation principle, therefore, separates the fruit into grades according to state of maturity.

When applied to dried fruit the method has proved satisfactory, but it appears to be more valuable when used to separate the fresh fruit before it is sent to the drier. More uniformity in drying is brought about by the gravity separation of fresh fruit because the moisture content of the fruit in any one grade is more uniform than can be the case with ungraded fruit.

Drying operations are thus speeded up and less of the under-dried and over-dried product is obtained. The flotation method, however, does not separate out infected fruit. Brown rot and similarly diseased fruit must be separated by hand.

253. **Congenital Loco in Chicks,** F. L. Knowlton.

Four years' hatching results are given and analyzed with respect to the inheritance of the loco factor, which factor causes crippled chicks of a distinctive type. The data indicate that this factor is inherited and that its mode of inheritance is probably that of a simple Mendelian recessive.

254. **Further Investigations on the Harvesting, Storing, and Ripening of Pears from Rogue River Valley,** Henry Hartman, F. C. Reimer, and R. K. Norris.

This bulletin deals with data obtained during the seasons of 1926, 1927, and 1928, on such varieties as Anjou, Comice, Bartlett, Seckel, Howell, and Winter Nelis. Picking pressures for these varieties are given. It is obvious from these studies that pears have a rather definite storage life. They can be held in cold storage for a limited period and then must be removed and disposed of. When they are kept in cold storage beyond their normal storage life, they do not ripen properly upon removal. While they may appear to be in good condition, upon removal to warm temperatures, the skin "scalds" or turns brown, the flesh remains hard, a foul odor is developed, and core breakdown may occur. The disease known as "pear scald" occurs only in pears that are held in cold storage past their normal storage life. The approximate length of time each variety can be safely held in cold storage is discussed in this publication. Storage humidities of 78 to 85 percent were found sufficient to prevent wilting in pears. It was found that most varieties of pears do not ripen properly in cold storage. To obtain full quality, the fruit should be ripened at temperatures varying from between 60° and 70° F. Ripening rooms are recommended for some varieties. Prompt handling after picking was found to be a vital factor in the handling of pears. Pears picked and allowed to stand in the orchard or packing house at prevailing temperatures ripen at least ten times as rapidly as they do at 32° F. They ripen much more slowly if attached to the tree than they do after picking at the same temperatures. When long keeping is desired, immediate refrigeration is essential.

255. **Electric Hay Hoists,** F. E. Price, A. W. Oliver, and E. L. Potter.

This bulletin presents the results of investigations regarding the labor-saving efficiency of electric hay hoists. In this study it was found that a good power hoist will replace the pull-up team and driver, can be operated satisfactorily with either fork or sling by one man on the wagon. A hoist will make the use of a gravity pull-back for the fork convenient and practical as the brakes will stop or slow up the carriage or fork at any place. The hoist makes possible the use of a larger fork but will not elevate the hay faster or in larger loads than is possible with horses without danger of breakage to the carriage or track. A good power hoist can be purchased for $80 to $100; it uses ½ kilowatt-hour per ton of hay hoisted, and the power costs 1 cent per ton at 3¢ per kilowatt-hour. One horse-power is required for each 135 to 150 pounds of load at a hoisting speed of 125 feet per minute.

256. **Use of Time by Oregon Farm Homemakers,** Maud Wilson.

This publication includes the more significant points developed in a study of the time element in the cost of household operation of representative rural homes. It is concerned mainly with the job of the homemaker—its content and the time demands of its various responsibilities, in type household situations. It notes briefly the kind and amount of help received in the home, and the character of the leisure activities of farm homemakers.

The average work period of the farm homemaker was found to be 63.7 hours per week, divided as follows: homemaking, 81 percent; farm work, 18 percent; other work, 1 percent. For 9 percent of the homemakers the work period was less than 50 hours; for 14 percent it was 75 hours or more. The average work day was 9.7 hours on week days and 5.5 hours on Sundays.

The 51.6 hours per week devoted to homemaking activities were distributed as follows: food activities, 47 percent; house, 18 percent; clothing and textiles, 22 percent; care of members of household, 7 percent; management, 3 percent; all other, 2 percent. Seventy-two percent of the homemaking time was devoted to the routine activities of the household—meals, cleaning, fires, laundry, and mending.

Farm homemakers worked longer than non-farm homemakers, mainly because of their farm work in addition to their homemaking. Ninety-seven percent of them did some farm work, the average amount being 11.3 hours a week. The three farm enterprises to which the most time was devoted were dairying, poultry, and fruits and vegetables.

The farm homemaker had an average of 102.7 hours of personal time per week, divided as follows: sleep and rest, 61 percent; physical care of self, 14 percent; leisure activities, 23 percent; other activities, 2 percent. With work periods of varying length there was a marked difference in amount of leisure time, but time for sleep and rest and physical care of self remained fairly constant.

Reading and informal social life were of about equal importance as leisure activities and together accounted for more than half of the leisure time of the average farm homemaker. Leisure activities carried on away from home and apart from one's family, aside from informal social life, were comparatively unimportant.

Farm homemakers received an average of 9.5 hours a week of help in their household duties, half of it being that of children. The amount of paid help was negligible.

Differences in household requirements which were a consequence of differences in ages of children or number of persons served were associated with variations in length as well as distribution of work periods of homemakers. Farm cooperators with no children averaged 60.5 hours at work, 26 percent of it in work other than homemaking. Those with children under one year worked 77.3 hours, of which 11 percent was in outside work.

Time given by homemakers to the care of a child under a year old was three times that given to a child between one and six, and twelve times that given to a child of grade-school age.

With respect to the number of persons in the household the time spent by the homemaker in meal preparation varied more than that of any other activity. For farm households of two to three persons it was 13.6 hours; for seven to eight persons, 18.7 hours.

Seasonal variations in farm work were chiefly accountable for seasonal variations in the work period. The peak load was in midsummer, with a secondary peak at Christmas holiday time.

Of the farm homemakers 43 percent had neither modern plumbing nor electricity, while 19 percent had both. Those with both water and electricity, spent 3 hours a week less upon meals, cleaning, and washing than those without these utilities.

Comparing homemakers as to amount of schooling, those with more schooling devoted more time to the care of their children and more of their leisure time to meetings and study and to work for organizations.

Time not needed for the essentials of homemaking was used by farm homemakers either in doing more farm work or in giving more attention to the "higher life" aspects of homemaking.

Farm and non-farm homemakers followed the same time-pattern in caring for household needs. Differences in amount and distribution of homemaking time were slight. When differences in equipment of houses and use of commercial services were allowed for, remaining differences were negligible.

257. **Trends of Tax Levies in Oregon with Emphasis Upon Rural and City Real Properties,** W. H. Dreesen.

The primary purpose of this study is to show the trends in rural and urban tax levies on the assessed value, equalized value, full cash value, and sale value bases of taxable property in Oregon. It was found that:

1. The weighted average levies on rural taxable property in the state have increased from 14.16 mills in 1910 to 35.93 mills in 1928 on the equalized value basis. On the full cash value basis the corresponding increase was from 10.02 mills to 21.23 mills, and on the sale value basis from 8.91 mills in 1911 to 15.46 mills in 1928. The latter levies applying only to real property values represent an increase of 73.51 percent during the period under consideration.

On the basis of selling value the taxes rose from $8.91 on a $1,000 parcel of rural real property in 1911 to $15.46 in 1928. On the full cash value basis the rise was from $10.02 to $21.23.

2. Total rural taxes have increased from $6,390,829.00 in 1910 to $20,334,636.28 in 1928, an increase of 218 percent.

3. The weighted average urban levies in the state have increased from 22.97 mills in 1910 to 51.43 mills in 1928 on the equalized value basis. On the full cash-value basis the corresponding increase was from 16.26 mills to 30.40 mills, and on sale value basis from 14.17 mills in 1911 to 28.82 mills in 1928. The latter levies represent an increase of 95.92 percent and apply to urban real property only. On the basis of selling value the taxes rose on the average from $14.71 on a $1,000 parcel of urban real property in 1911 to $28.82 in 1928. On the full cash-value basis the corresponding increase in taxes was from $16.26 to $30.40.

4. Total urban taxes rose from $9,040,724.00 in 1910 to $28,618,546.06 in 1928, an increase of 217 percent.

5. Two sets of factors or influences are consistently affecting land values; the depreciating influences of rising tax levies and the appreciating influences of publicly provided services and utilities, such as better schools, better roads, better sanitation, greater protection to life and property, together with the many other services provided by the modern state.

The latter influences, although no less real, are less tangible and therefore attract less attention, whereas the former are tangible and measurable and are therefore more generally observed.

On the average from 13.7 to 16.6 percent of the market value of rural land and from 23.83 to 21.35 percent of the market value of urban land, assuming a 5 percent investment basis, is absorbed by the present tax levy increases over the prewar average levies.

258. **The Butter Industry of Oregon,** E. F. Larrabee and G. Wilster.

In this publication the results of investigations regarding the quality of butter and methods of handling cream on the farm and in the creamery are presented.

In the study it was found that there is a great variation in the amount of butter made each month, and the butter scorings showed a wide variation in the quality of butter made. There was a pronounced lack of uniformity in the composition of 261 samples of butter analyzed. Some samples of butter had a high yeast and mold count. The quality of cream received by the 50 creameries visited showed considerable variation. Cream was not delivered at the creamery at frequent intervals. Feed and weed flavors were prevalent in the cream at certain seasons of the year. It was found that manufacturing methods at the plants showed noticeable variation, but that butter scoring 91 can be made under present conditions. It was found that it was possible to make a still higher quality of butter in the state.

259. **Sprays, Their Preparation and Use,** R. H. Robinson.

This bulletin discusses the preparation of various spray materials, outlines methods for the home preparation of certain of these, and emphasizes precautions that should be observed in order to obtain a high-grade product. General information is given regarding commercial materials, especially the newer ones. Recommendations are made for the mixing of various combination sprays and warning is given against combining incompatible mixtures. A compatibility chart is depicted for the insecticides and fungicides used in Oregon. Methods for the preparation of spray materials and adhesives are also included.

260. **Marketing Willamette Valley Wools Through the Pacific Cooperative Wool Growers,** E. B. Mittleman.

Following the collapse of wool prices in 1920-21, a group of growers representing about 50 percent of the sheep in the Willamette Valley organized the Pacific Cooperative Wool Grower. Besides reacting to a demoralized market the growers saw in the organization an opportunity to overcome the ordinary handicaps incident to the disposal of wool in distant markets and to deal more effectively with grades and shrinkage. The

present study is concerned with the experience of the organization in the Valley in so far as it relates to receipts and sales of wool and credit relations with the grower.

Willamette Valley wools do not vary materially in shrinkage from year to year but comprise all grades, with coarse and medium predominating.

In its general sales program, the Cooperative takes account of the spring glut incident to shearing and the seasonal decline in consumption. It withholds its wools from the market during this period and places them on the market as prices advance.

That the Cooperative is in a measure bound in its marketing program by the financial conditions of its members is perhaps self-evident.

Two remedies suggest themselves. One remedy is to improve the credit facilities available to the grower. The other is to standardize the financial qualifications of the membership.

261. **Willamette Valley Wools in Relation to Local Consumption,** E. B. Mittelman.

Nine mills operating in the Willamette Valley or having general offices in Portland, which is located at the mouth of the Willamette River, annually consume about 6,500,000 pounds of wool. In the Valley about 3,200,000 pounds are annually produced, but considering the whole of Oregon, Washington, and Idaho, which are immediately tributary to Portland as a shipping point, about ten times that amount is available. Nevertheless, the feeling is wide-spread that there is a closer relationship between the mills and the Valley growers than between the mills and the growers in the wider area. The aim of this study is to determine that relationship in so far as it can be determined through consumption and production records. For completeness some national and some world data are considered.

Considering the increase in the proportion of coarse wools consumed nationally at comparatively steady prices, and the relatively large proportion of coarse wools consumed locally, it would appear advisable not only to maintain the size of present flocks producing these wools, but even to increase them where consistent with feeding and running conditions.

The local mills, although chiefly woolen mills as distinguished from worsted, are not sufficiently differentiated from those in other parts of the country taken together to justify a production program suited exclusively to their needs. Moreover, the local mills consume only about half of the wool locally produced. As woolen mills they show a predilection for short fibers and are outbid for the long by eastern buyers.

The significance of the local mills lies in the competitive influence they at times bring to bear in reducing the differential that normally arises between Boston and the Valley.

262. **Electric Brooders,** F. E. Price, A. G. Lunn, and F. E. Fox.

This bulletin presents a summary of the investigations of the operations and performance of electric brooders and their effect on mortality, rate, weight of growth, and feed requirements of baby chicks. The results indicate:

1. The cost of heat for brooding chicks was found to be approximately the same when using electric brooders of good construction at the rate of 3¢ per kw-hr. as when using a coal stove with briquets at $17.00 per ton.

2. The labor required in operating electric brooders is much less than for coal-stove brooders.

3. Electric brooders eliminate a fire hazard that exists when using fuel-burning brooders.

4. A roosting platform of ½-inch mesh hardware cloth supported by a frame of 1 x 3 lumber on edge is recommended to provide a sanitary roosting place.

5. Electric brooders should have sufficient heating capacity to maintain a temperature of 100° F. with no chicks under the hover during the coldest brooding weather.

6. Electric brooders do not require supplemental room heat when the outside temperature is only slightly below freezing. Chicks have been brooded successfully with electric brooders without supplemental room heat with an outside temperature as low as 4° F. above zero.

7. There is a large variation in different types and makes of electric brooders, and some are more satisfactory than others.

263. **The Market Situation and Outlook for the Oregon Canned Fresh Prune,** Milton N. Nelson and W. H. Belden.

Conclusions presented in this bulletin as a result of study of the Oregon canned fresh prune are as follows:

1. The prune industry in Oregon during recent years has been confronted with the problem of greatly increased production and consequent low prices. Unless additional market outlets can be found, low prices are apt to continue for some time. The canning of fresh prunes, now in its infancy, offers an attractive outlet.

2. The Oregon prune has undoubted excellence for canning, being a tart-sweet prune of large size and fine flavor.

3. The percentage of the total prune crop of the Pacific Northwest used in canning is small compared with the dried product or even the fresh. The average figures for 1925 to 1929 show that nearly 60 percent were dried, 33 percent were shipped fresh, and only 7 percent were canned. In Oregon (using the 1925-1929 average) 8.7 percent were utilized in canning, 16.8 percent were shipped fresh, and 74.5 percent were dried.

4. Canned prunes comprise less than 2 percent of the total fruits canned in continental United States. But since 1925 the rate of growth in prune pack in the Pacific Northwest has been considerably greater than that of all other canned fruits combined.

5. The annual production of canned prunes today is approximately that of Hawaiian canned pineapple or canned apricots twenty years ago, and about one-third that of canned peaches.

6. The limited geographic area in which the Italian prune thrives is a consideration of great importance to growers of the Pacific Northwest, as it means that they would derive the full benefit of advertising and sales promotion calculated to increase consumption of the canned product.

7. Prunes have an advantage over certain other acid fruits in that they seldom develop pinholes or swells in the can.

264. **Irrigated Pastures for Dairy Cattle,** I. R. Jones and P. M. Brandt.

This bulletin presents the results of pasturing 11¼ acres of irrigated Ladino clover. Dairy cows were grazed on an irrigated pasture developed on land that had not produced a crop for several years.

1. From being a liability the pasture has been made to produce a net return of about $46 an acre for the season. With all costs taken into consideration these returns are equivalent to about 30 percent interest on the $150-per-acre investment.

2. Ladino clover will grow luxuriantly on poor soil under irrigation. Because of its shallow root system, however, it needs a large amount of water.

3. The stand is apparently not thinned by extremely heavy pasturing. It is thicker now than at the end of the 1928 season.

4. Some difficulty has been experienced with cows bloating on this pasture.

5. Production costs are considerably lowered below the barn-feeding cost when animals are kept at a corresponding plane of production on pasture.

6. The milk production on pasture will not decline as rapidly during July, August, and September as it does under average Willamette Valley conditions.

7. With irrigated pasture, milk production can be maintained at a fairly constant level during the late summer at a lower cost than it can be produced in winter.

8. Because of the inconvenient location of the pasture it was necessary for the cows to walk an average of four miles a day in going to and from the pasture.

9. During the 1929 season the 11¼ acres of Ladino clover were pastured a total of 7,032 cow days. This is an average of 42.1 cows per day for the 11¼ acres, or 3.74 cows per acre for the pasture season of six months.

10. The pasture return was equivalent to 17 pounds of alfalfa hay, or 10 pounds of alfalfa and 19⅓ pounds of corn silage per cow per day.

11. With alfalfa hay at $10 per ton and corn silage at $7 per ton, the value of the pasture per cow per day in feed saved was 11.77¢. The cost of the pasture per cow per day was 4.39¢, or a net return per cow per day of 7.38¢. This is equivalent to a return of about $46 per acre for the pasture season.

12. This pasture is worth even more than the figure indicated since its value was determined on a total-digestible-nutrient basis without regard

to its superior value as a source of succulence, its high percentage of good-quality proteins, and its high mineral and vitamin content. These latter are important considerations in determining the value of a feed for dairy cattle not only for lactation, maintenance and gain in weight, but also for physical well-being and breeding efficiency.

265. **Lamb Marketing Investigations in Western Oregon,** H. A. Lindgren and E. L. Potter.

The results of this study of lamb marketing in Western Oregon are summarized as follows:

1. Western Oregon lambs topped the market in May and June.

2. Few Western Oregon farm lambs were good enough to top the market after July 1.

3. Western Oregon farm lambs marketed later than the middle of July meet competition from range sections.

4. Lambs weighing from 60 to 80 pounds brought top price if fat.

5. Milk-fat lambs at Easter time usually command a fancy price.

6. Lamb prices are usually highest during the early spring months and gradually decline from then until fall.

7. Forty-seven percent of the lambs were thin and brought $1.85 per hundred less than lambs in a desirable condition.

8. Nine and one-tenth percent of the lambs were heavy and brought $2.75 less per hundred than lambs of desirable weight and condition.

9. Four percent of the lambs were scrubs and brought $4.14 per hundred less than lambs in good condition.

10. Seven percent of the lambs were long tailed and bucky and brought $2.50 per hundred less than good lambs.

11. San Francisco and Los Angeles offer a desirable outlet for Western Oregon early lambs. Their requirements are essentially the same as those at Portland.

12. Western Oregon lambs did not hold up satisfactorily in Chicago shipments.

13. Feeder lambs from Western Oregon so far have had no satisfactory outlet.

14. On a crowded market, buyers discriminate severely against off-type and off-quality lambs, while the same objections are often overlooked when the supply is small and the demand keen.

266. **Studies in Fascioliasis in Oregon Sheep and Goats,** J. N. Shaw and B. T. Simms.

This bulletin presents results of study in Fascioliasis in Oregon sheep and goats and submits a discussion of the life-history, methods of finding the fluke ova, effect of temperature on snails, and artificial infestation. The symptoms and lesions of the disease are described, together with treatment and methods of destroying the snail. The results of the study indicated that freezing killed embryonated ova but did not affect those not

embryonated. Snails lived at 37° F. for a month without food when water was provided. Cercariae are capable of living in the snails and being discharged for more than six months from date of the infection. Individual snails are capable of living with large numbers of cercariae in them, 580 having been discharged by one specimen. Carbon tetrachloride in 1 c.c. doses destroyed mature and nearly mature flukes in livers of sheep and goats. Snails were destroyed by use of copper sulfate broadcast on habitat. The cost of application was $5.25 per acre. The destruction of snails did not prevent their reappearance on the same pastures the following year.

267. **Cost and Efficiency in Producing Pears in the Rogue River Valley, Oregon,** R. S. Besse, W. S. Brown, and L. P. Wilcox.

This bulletin presents results of investigations on (a) cost of producing pears in the Rogue River Valley; (b) the factors affecting costs; (c) methods by which costs may be reduced. The study includes the records of 6,342 acres of bearing pears, which produced a total of 874,815 boxes of packed and graded fruit in 1924, 1925, and 1927.

1. A wide variation in costs, ranging from below $1.00 per box to more than $6.00 per box, was found on the different farms.

2. The average cost for 1924, 1925, and 1927 was $1.48 per box, $68.71 per ton, $2.98 per tree, or $201.61 per acre, which includes both cash and non-cash items, allowing the grower current wages for his labor, 5 percent interest on his investment in bearing pears, together with depreciation. Three-fifths of this cost represents cash expenditure and two-fifths consists of the operator's own labor, depreciation, and 5 percent interest on investment.

3. Eighty percent of the cost of producing pears is expended in preharvest operation.

4. Yield is the dominant factor in reducing cost per box.

5. Nine major factors which are closely associated and related in their influence exercise a joint effect on yield and cost. These factors are fertilizing, cover-cropping, cultivation, blight control, spraying, pruning, orchard heating, age of trees, and irrigation.

6. Labor practices and requirements which represent the largest cost item in control of the grower, are presented as (a) money cost; (b) hour requirements; (c) total labor requirement per acre for each operation; (d) comparison of labor requirements in major operations on both horse and tractor farms; (e) utilization of labor on most profitable and all farms.

7. The organization and earning power of the pear-farm business, including utilization of the land, capital requirement, average profit per box and per acre, and comparative earnings on the best farms and on the average farms, are discussed and illustrated.

268. **Milk Cooling and Refrigeration,** F. E. Price.

This bulletin presents a summary of the results of a study of the rate of cooling and bacterial growth of milk cooled by electric refrigeration in a tank-type refrigerator. Specifications of homemade, tank-type refrigerators are submitted and the cost of equipping and operating such refrigerators is given.

SOIL SURVEY REPORTS COMPLETED

In the present biennium the following soil survey reports, summarizing the field work of the previous biennium, were completed and published: Clackamas county, 623,360 acres; Linn county, 977,920 acres; and Polk county 476,160 acres respectively outside of the National forest.

These reports describe the topography, climate, agriculture, soil characteristics, physical and chemical composition, crop adaptation, and methods of improving, and the utilization of the land surveyed.

Soil Survey Report of Lane County, Oregon (in press). E. J. Carpenter, in Charge, and Arthur Albin, U. S. Bureau of Soils, and V. D. Young, Oregon Agricultural Experiment Station.

This report presents 820,168 acres of land on a colored map, dividing the soils into 15 series of 31 distinct types.

Soil Survey Report of Marion County, Oregon (in press), E. F. Torgerson, in Charge, Oregon Agricultural Experiment Station, and T. Glassey, U. S. Bureau of Soils.

Areas surveyed 557,440 acres, divided into 23 soil series and 44 distinct soil types. The location, extent, characteristics, methods of improving and utilizing these soils are described.

Soil Survey Report of the Grand Ronde Valley, Oregon (in press), A. E. Kocher, U. S. Bureau of Soils, in Charge, and Arthur Albin, Oregon Agricultural Experiment Station.

The location, extent, characteristics, methods of improving and utilizing 205,000 acres divided into four divisions of 12 soil series and some 32 distinct soil types, are presented in this report. The soil types best suited to irrigation belong to Paloose, Walla Walla, and La Grande series, and include 20,500 acres. Five soil types belonging to Paloose, La Grande, and Catherine series suited to supplemental irrigation include 20,150 acres. Seven wet soil types belonging to Nibley, Willow, and Embler series need drainage and occupy an area of 39,400 acres.

COMPLETED REPORTS NOT PUBLISHED

Soil Survey Report of Columbia County, Oregon, E. F. Torgerson, in Charge, R. D. Lewis, Oregon Agricultural Experiment Station, and W. G. Harper, U. S. Bureau of Soils.

This report describes the topography, climate, agriculture, and soil of Columbia county. Soil characteristics, physical and chemical composition, crop adaptations, and methods of improvement are outlined.

Irrigation and Drainage Study of Baker Valley, M. R. Lewis.

A mimeographed progress report has been prepared dealing with irrigation, drainage, ground-water and alkali studies in Baker Valley conducted under a cooperative agreement between the Oregon Agricultural Experiment Station and the U. S. Division of Agricultural Engineering.

Drainage and Flood Control Survey in Coquille Valley, M. R. Lewis.

A preliminary report has been prepared summarizing studies of run-off drainage and flood conditions in Coquille Valley and possibilities as to improvement of some 12,000 acres of wet land affected. This study has been made in cooperation with the U. S. Division of Agricultural Engineering.

Drainage and Water Table Studies in Rogue River Valley, Arch Work.

After-drainage conditions, resulting from irrigation and seepage, became alarming; consequently, early in the season of 1929 the cooperation of the Division of Agricultural Engineering was obtained and a thorough study was undertaken of the irrigation, drainage, and water conditions in the Rogue River or Medford District. These studies upon which a preliminary report has been prepared are being continued.

Ground-water Survey of the Willamette Valley, A. M. Piper.

This report deals with the possibility of obtaining ground-water for development by means of wells for supplemental irrigation in the Willamette Valley. The report covers a field survey conducted during the biennium under cooperative agreement between the Oregon Agricultural Experiment Station and the Water Resources Branch of the U. S. Geological Survey.

The Theory of the Flow of Ground Water as Applied to Drainage Wells, M. R. Lewis.

This paper is a technical discussion of the factors involved in the movement of water from water-bearing formations through well strainers under conditions encountered in pumping for drainage or irrigation. The report covers one phase of the cooperative irrigation and drainage investigations being conducted by the Oregon Agricultural Experiment Station in cooperation with the Department of Agriculture.

Drainage and Irrigation by Means of Wells, M. R. Lewis.

This is a progress report of studies dealing with the possibilities of providing drainage by means of pumping, particularly in the irrigated sections and using the water for augmenting the irrigation supply. The work is conducted under the agreement referred to above.

Agricultural and Economic Survey of Tumalo Irrigation Project, W. L. Powers, R. E. Stephenson of the Oregon Agricultural Experiment Station, and W. W. McLaughlin and P. A. Ewing of the U. S. Division of Agricultural Engineering.

This report contains the classification of soils made of the project in the field together with the result of studies of the water rights and irrigation works and description of topography, drainage conditions, costs and methods of clearing and leveling, climate, types of farming, extent of production, market and transportation conditions, farm indebtedness, land tenure, valuation, tax-assessment rates, estimates of productive value and possibilities of crop expansion. A land-settlement program, rehabilitation plans for the irrigation system and recommendations or plans for refunding district indebtedness are also included.

Agricultural and Economic Survey of Summer Lake Irrigation District, W. W. McLaughlin, P. A. Ewing, R. E. Stephenson and W. L. Powers.

This is another of a series of reports prepared at the request of the State Reclamation Commission covering a rehabilitation or feasibility survey of Summer Lake Irrigation District.

Agricultural and Economic Survey of Silver Lake Irrigation District, W. W. McLaughlin, P. A. Ewing of the U. S. Division of Agricultural Engineering, W. L. Powers, R. E. Stephenson of the Oregon Agricultural Experiment Station.

This report deals with the agricultural and economic conditions and productive value within the Silver Lake Irrigation District and contains recommendations for its rehabilitation.

Agricultural and Economic Survey of the Payette-Oregon Slope Irrigation District, W. L. Powers and P. A. Ewing.

This is another of the series of feasibility reports to the State Reclamation Commission and deals with the agricultural and economic conditions of the land included.

Agricultural and Economic Survey of the Lone Pine Project, R. E. Stephenson, W. L. Powers, W. W. McLaughlin, and P. A. Ewing.

This project, otherwise referred to as Crook County Improvement District No. I, is located near Train Crossing east of Terrabonne. It has been surveyed and reported upon as to agricultural and economic conditions and recommendations as to its salvage value and methods of rehabilitation have been included in the report.

Economic Survey of Owyhee Project Oregon-Idaho, A. C. Cooley, Rhea Luper, W. L. Powers, L. R. Breithaupt.

The original feasibility survey of Owyhee Project in which the State Experiment Station participated was prepared when the bill was pending in Congress to provide for repayment of construction cost on federal projects on the basis of 5 percent of the gross crop value. Under terms of the laws which were later enacted and which govern the conditions of settlers on projects, such as the Owyhee at this time, repayment is required in forty years. This and other developments made necessary a resurvey, which was made cooperatively by representatives of the United States Department of Agriculture, State Engineer's office, and specialists from the Oregon Agricultural Experiment Station. The report includes an agricultural and economic survey and a number of recommendations, some of which have already been put into effect, and which extend and provide better terms for settlers present or those to come upon this project. The total area to be served is 139,000 acres, of which some 40,000 acres is now irrigated mainly by pumping. The construction cost is estimated at approximately $18,500,000.

An Economic Survey and Investigation of Hermiston, West Extension, Westland and Stanfield Districts, H. K. Dean, L. R. Breithaupt, G. R. Hyslop, and W. L. Powers.

At the request of the Federal Reclamation Service a survey and economic study were made of the above projects. Upon this survey recom-

mendations were based which have since been adopted, in part, relieving settlers on the Hermiston and West Extension Projects from payment of further construction charges. Recommendations relative to the Stanfield project have not yet been adopted or put into effect.

Economic and Agricultural Survey of the Scappoose Drainage District, P. A. Ewing, U. S. Division of Agricultural Engineering, W. L. Powers, C. V. Ruzek, E. F. Torgerson of the Oregon Agricultural Experiment Station.

This report contains a detailed soil survey for which the field work was done by C. V. Ruzek and E. F. Torgerson and an economic study was made by P. A. Ewing and W. L. Powers. The study had for its purpose the determination of relative productive value of all soil types and areas in the project as well as a determination of crops and types of agriculture best suited for the conditions.

Memorandum Regarding the Position of the Oregon Experiment Station in Reference to New Commercial Fungicides and Insecticides. February, 1929, Don C. Mote, H. P. Barss, and J. S. Jones.

List of Injurious Insects Found in Oregon.

Prepared by department for Western Plant Quarantine Board, February, 1929, at request of Charles A. Park, President Oregon State Board of Horticulture.

Alfalfa Weevil Infestation in Jackson County Near Medford, D. C. Mote. July, 1929. Prepared for State Board of Horticulture.

Nursery Insect Control Investigations and Service, September, 1929, D. C. Mote.

Memorandum on Pea Weevil Conference, September, 1929, Don C. Mote.

Report on Wireworm Damage in Oregon.

Prepared for M. C. Lane, Federal Entomologist on Wireworm Investigations.

Progress Report on the Spray Residue and Codling Moth Problem, December, 1928, D. C. Mote, B. G. Thompson, R. H. Robinson, and R. K. Norris.

Emergency Problems in Entomology, January, 1930.

Outstanding Problems of the Prune Industry, January, 1930.

Report Grain Weevil Problem in Terminal Warehouse of the Portland Public Dock Commission, September 10, 1929.

Suggestions for the Mosquito Control Campaign in All Infested Areas of the Pacific Northwest.

Prepared for Special Committee of the Portland Chamber of Commerce, February 26, 1930.

Report on the Insects that May Be Troublesome on the Wapato Farm Project, November 25, 1929.

STATION CIRCULARS

86. **The Wheat Jointworm in Oregon,** P. R. Chamberlain.

This circular is a brief statement of the character of attack of the wheat jointworm and the best known methods of control. This pest has been serious in the wheat-growing states of the East for 80 years or more but it was not known to occur in Oregon until July, 1926, when it was found infesting wheat stubble in Molalla, Clackamas county.

87. **Commercial Fertilizers,** R. H. Robinson, Carl F. Whitaker, and D. E. Bullis.

In carrying out the provisions of the Oregon Fertilizer and Agricultural Lime laws approximately 200 samples of fertilizing materials have been inspected and analyzed. The results of these analyses are tabulated in this circular. The circular also contains a general discussion pertaining to the active plant foods contained in fertilizers and methods of calculating the commercial value of various mixtures.

88. **Motor-driven Green Feed, Root, and Straw Chopper,** F. E. Price, George W. Kable, and F. E. Fox.

This circular is one of a series of publications issued by the Station with the intention of suggesting profit-making and time- and labor-saving uses for power in farming operations. The facts presented in this publication indicate: (1) Alfalfa and kale must be chopped to the length of ½ inch or less to avoid waste. (2) Hens eat stems of green alfalfa when chopped, but waste the stems if fed unchopped. The midrib of the kale leaf is wasted if not chopped. (3) When a hand-power green-feed cutter is operated by a small electric motor, the number of pounds cut per hour is increased approximately three times. (4) Cutters having throats up to ten inches may be operated by ½ or ¾ horse-power motor. (5) Cutters may be run at speeds up to 350 r.p.m. A very satisfactory speed for the larger hand machines is 200 to 250 r.p.m.

89. **The Jerusalem Artichoke,** H. A. Schoth.

The Jerusalem artichoke is adapted to production in a large part of Western Oregon and in many of the irrigated sections of Eastern Oregon. Artichokes have a number of uses. The tubers can be used as stock feed and are particularly well adapted for feeding hogs. The tops are used as forage and make a satisfactory silage. Artichokes contain a high percentage of levulose sugar and are considered to have high dietary value, especially for diabetes patients. The adaptations, varieties, and culture of artichokes are discussed in the circular.

90. **Meaning and Use of Willamette Soil Survey,** E. F. Torgerson and W. L. Powers.

A condensed key of all soil series in the Willamette Valley arranged by groups, an explanation of soil-survey methods, and the use of the maps and reports are presented. The soil survey serves as an invoice of agricultural resources, gives information as to methods of soil maintenance and management, aids new settlers in selecting location and type of agriculture, guides the county agents or soil specialists in advising farmers, forms the basis for the introduction of new farm crops and practices, is a valuable guide for determination of irrigation requirements and the feasibility of

drainage for different soils, is useful in locating highways, gives the basis for a systematic study of fertilizer needs of different soil types, and lays a foundation of investigation for developing a permanent system of agriculture for every kind of soil on every farm. Directions are given for collecting soil samples and examining the land in the field with the aid of the soil map.

91. **English Walnut Production in Oregon,** C. E. Schuster.

This circular presents the results of an investigation covering walnut production in Oregon, including a discussion of the following main points: walnut plantings, temperature requirements, soil requirements, elevation, varieties, propagation, methods of planting an orchard, cultural practices, and diseases.

92. **The Oregon Apple-washer,** Henry Hartman.

This circular presents specifications for making the Oregon apple-washer, including construction, elevators, towel wipers, driving mechanism, the rinsing unit, and suggests methods for operating the machine.

93. **Scours in Sheep and Goats in Oregon,** J. N. Shaw.

This circular presents the results of investigations of scours in sheep and goats. The causes, symptoms, diagnosis, control, and eradication of the disease are presented. In this investigation it was found that: (1) Scours in sheep and goats is an important problem in Oregon. (2) It is usually the result of infestation with worms. (3) Either a microscopic examination of droppings or an autopsy is necessary for a diagnosis. (4) Many owners wait too long before calling a veterinarian and getting a diagnosis. (5) The most serious of the worms which cause scours in Oregon can be killed through proper treatment. (6) Control of losses from scours is both practicable and economical.

94. **Cost of Producing Sheep on Western Oregon Farms,** O. M. Nelson.

This circular presents the results of cost-of-production of sheep in Western Oregon as follows:

1. Farm ewes pay $10.00 per ton for hay, $30.00 per ton for grain, 8 percent on all sheep investment, 40¢ per hour for labor, and rent for all pasture, when wool is worth 35¢ per pound and lambs 10¢ per pound.

2. The average annual cost of running farm sheep is $9.96, including interest and depreciation.

3. The useful life of the farm ewe averages six seasons.

4. Death loss in a well managed flock will average about 6 percent.

5. Ewes with broken mouths or spoiled udders are not profitable.

6. Lamb prices are usually highest in April and then decline until July.

7. Rams of the early maturing types are necessary to produce lambs that will mature and fatten before dry weather.

8. About 70 percent of the annual income from farm sheep is from the lambs and only 30 percent from the wool.

9. Sheep in Western Oregon require pasture to the greatest possible extent both for economy and for health and vitality.

10. The net cost of growing a yearling ewe from weaning to breeding age is $3.90. With market lambs worth $7.50 per head the total cost of the yearling ewe at breeding time would be $11.40.

11. Since the ewe lamb increases in value the first year, this year is as profitable as any other.

12. The annual cost of running pure-bred ewes is about $30.00 per head. The increase over the cost of running commercial sheep is due to the greater capital investment.

13. Pure-bred lambs at weaning cost the producer from $17.50 to $26.00 per head depending on the value of breeding stock used, including death loss, depreciation, and interest.

14. Sown pastures or irrigated pastures are expensive but are often necessary to produce good lambs.

15. Pure-bred lambs and yearlings cannot be pastured successfully on native sod during July and August.

95. **The Chemical Composition of Insecticides and Fungicides,** R. H. Robinson and Carl F. Whitaker.

This publication reports the chemical analyses of various insecticides, fungicides, and weed killers sold in the State of Oregon. A brief discussion is given of each class of compounds, indicating the quality of the various materials offered on the Oregon market, and suggesting points that must be taken into consideration when purchasing different spray materials.

96. **Potato Diseases in Oregon and Their Control,** M. B. McKay and T. P. Dykstra.

This circular describes the general control practices now employed against the potato diseases common to Oregon. Recommendations are based chiefly on the results of experiments conducted by the Oregon Station and extending over a dozen years. Detailed directions are given for all the practical operations advocated to protect the crop against disease losses. A key to some twenty-eight potato troubles, designed to help the grower identify potato troubles accurately and quickly, is followed by a detailed discussion of each malady and its control. The reader is given the reasons which lie back of each control practice. Carefully selected illustrations and diagrams are used liberally as an aid to understanding.

35. **The Cherry Fruit-fly, 1930.** Don C. Mote.

The serious losses experienced by canners and growers in 1929 and the many requests for information, made it necessary to reprint Station Circular 35, containing the best-known control measures for the cherry fruit-fly.

REPORTS PUBLISHED IN TECHNICAL JOURNALS

Why Soil Study Has Come to Be an Exact Science, W. L. Powers in *Northwest Science,* February 1929.

A modern view of soils is developed to show that soils are natural dynamic bodies resulting from aging of parent materials under different

climatic conditions. The methods of study required are different from those of pure chemistry, geology, or physics, since natural soil has well developed layers encountered at different depths and contains colloidal clay with capacity for base absorption and exchange, and also because it contains organic material and forms a medium for biological activity.

Chemical Characteristics of Northwest Peat Soils, W. L. Powers in *Journal of International Society of Soil Science,* April 1930.

The chemical studies of profile samples of soil from the main particular areas in the Northwest have resulted in grouping them into four classes. Field and plant-house fertilizer trials using several crops as indicators and checked with periodical analyses show that these soils generally respond to applications of potassic salts and barnyard manure. In the Coast region lime is also important. Inoculation with upland soil or a little well-decayed barnyard manure has been very helpful. Potassic salts have increased the concentration of soluble potassium and resulted in increased yield of mint oil, larger yield of flax fiber and a higher quality of potatoes.

The Role of Sulfur in Plant Nutrition, W. L. Powers, in *Journal of Agronomy,* April 1930.

The value of sulfur as a fertilizer for legumes was established by the Oregon Experiment Station in 1912. Studies have since been conducted to learn the extent of areas which respond to the treatment and the ultimate effect of sulfur applications. Sulfur is found to provide a more favorable concentration of sulfate and of calcium in numerous soils benefited and to improve the reaction for plant nutrition in the arid sections. In the subhumid and semi-arid sections where sulfur increases the legume yields, it is found to increase the content of nitrogen and protein and of calcium so that the alfalfa corresponds better in feed value than that produced in the typical arid sections. The soils that respond best are the calcareous, basaltic lands with good drainage, moistened with nearly pure water.

Wind Contributes to Alkali on Lee Shores, W. L. Powers, in *Science News Service,* September 1927.

The conditions that give rise to the development of alkali land are those favorable for high evaporation with impeded soil drainage and intermittent wetting with a salty solution and also those subject to movement and accumulation of salts by wind as well as water. Intermittent lakes have been observed to dry up and the surface become salty following which this surface was transferred to the lee shore. The alkaline areas are most extensive on the lee shore of the lake basins in Southeastern Oregon.

Removal of Soluble Salts from Black Alkali Soils, W. L. Powers, in *Second International Congress of Soil Science Proceedings,* 1930.

This paper is a progress report of experiments dealing with the reclamation of virgin black alkali land near Vale, where the oldest experiments of the kind in the Northwest are situated. Deep drainage, copious irrigation with water of good quality and chemical treatment are almost essential for the reclamation of these lands. Sulfur is the most effective chemical; it is more economically used in combination with manure or legume green manure. From 50 to 85 percent of the soluble salts have been removed by the most favorable treatments under study, including a greater

part of the initial content of sodium carbonate or black alkali. The soil has been largely converted from a black alkali or sodium clay to a normal soil of calcium clay with most favorable treatments. Trials include promising alkali-resistant forage plants, which afford fair carrying capacity during reclamation. The Russian Olive and other alkali-hardy trees have proved of value as windbreaks in lessening the shifting of salts by wind.

A Fertilizer Spreader for Plot Treatment. W. L. Powers, in *Journal of Agronomy,* 1928.

A hand implement is described and illustrated, which costs about $10 for material and can be used for trial experiment plots or other small areas.

Properties of Colloids in Willamette Soils, R. E. Stephenson, in *Soil Science.*

The amounts of colloids contained in different horizons of representative soil profiles of the Willamette Valley have been separated and determined, and their chemical composition and the amount of changeable basis retained are also determined. They are reported in this study. These characteristics affect physical properties and composition of the different soils and indicate the extent to which aging has progressed.

Nitrogen and Organic Matter as Related to Soil Productivity, W. L. Powers and R. D. Lewis, in *Journal of Agronomy* (in press).

A three-year rotation of barley, alsike clover, and beans has been maintained in the irrigation field of the Oregon Experiment Station for more than seventeen years. In this experiment certain plots are manured once in the three-year rotation. There is an irrigated range and a dry-farm range, and in addition continuously cropped plots are provided. The bean yield with continuous cropping had declined from 12 to 4½ bushels a year. With the rotation and light manuring, each rotation under supplemental irrigation, the yield was built up to 36⅔ bushels. The yield an acre-inch has been tripled and the water requirement per unit dry matter cut in two by the soil building treatments. Soil analyses show a correlation between the increased production and a gain in soil nitrogen and organic matter amounting to nearly 800 pounds gain in nitrogen an acre and about eleven times this much more organic carbon.

Seasonal Variation of Nitrates in Willamette Valley Soils as Influenced by Liming and Cropping, W. V. Halversen, in *Journal of the American Society of Agronomy,* Vol. 20, No. 8, pp. 868-875, August 1928.

This paper presents data showing that no excess of nitrates can be found under cereals growing on Willamette silty clay loam irrespective of fertilizer treatment. Lime, however, does favor nitrate formation in fallow plots of the same soil type. This favorable action of lime is not sufficient to predict favorable response on growing crops because climatic factors which affect the moisture and temperature relationships of the soil may mask the results. An efficient system of soil management must take into account the supplying of an adequate quantity of available nitrogen to growing crops during the winter and spring months.

The Value of Nitrification Tests When Used on Soils Representing Extreme Contrast in Physical and Chemical Properties, W. V. Halversen, in *Soil Science,* Vol. 26, No. 3, pp. 221-231, September 1928.

Standardized methods for determining the nitrifying powers of soils have often been the subject of severe criticism. In this study of soils representing extreme contrast in physical and chemical properties it was found that by using four methods simultaneously, a very close agreement could be obtained on normally productive soils of varied cropping and fertilizer treatment, but when these same methods are used on light, sandy, arid soils of low buffer capacity the results are inconsistent. The lack of conformity of the results obtained on light, sandy soils is probably due to lack of residual effect of the fertilizers added and lack of buffer capacity.

The Physiological Effect of Rations Restricted Principally or Solely to the Alfalfa Plant: 1. The Calcium, Phosphorus and Nitrogen Metabolism of Dairy Cattle, J. R. Haag and J. S. Jones, Department of Agricultural Chemistry, and I. R. Jones and P. M. Brandt, Department of Dairy Husbandry, in *Journal of Dairy Science,* Vol. XII, 6, November 1929.

This is the first of a series of papers dealing with the metabolism of dairy cattle restricted largely to alfalfa. Nitrogen, calcium, and phosphorus balances were determined for 12 ten-day periods, during which the daily milk yields varied from approximately 9 to 18 kilograms. The rations used consisted of alfalfa hay with and without supplements of starch, linseed-oil meal, or di-sodium phosphate. Cows in the early lactation period were usually in positive calcium balance; in negative balance when the hay contained less than 2 percent nitrogen; and always in negative phosphorus balance when only alfalfa hay was fed. Feeding di-sodium phosphate changed the negative phosphorus balances to slightly positive balances. These results are interpreted as indicating that where the rations of dairy cattle consist largely of alfalfa hay, attention can profitably be given to the choice of supplements that are rich in phosphorus.

New Solvents for the Removal of Arsenical Spray Residue, R. H. Robinson in *Journal of Industrial and Engineering Chemistry,* Vol. XXI, pp. 1132-1140.

A study of aqueous solutions of the different classes of compounds and the combinations of compounds as solvents for lead arsenate spray residue was made. No single compound was found superior to hydrochloric acid. Combinations of certain sulfates or chlorides with hydrochloric acid dissolve far larger amounts of lead arsenate than the hydrochloric acid alone. The laboratory studies indicated that sodium sulfate combined with very dilute hydrochloric acid might be found to be a practical solvent for the lead-arsenate solution.

Facilitating the Removal of the Spray Residue, R. H. Robinson, in *Journal of Economic Entomology,* Vol. XXII, pp. 693-700.

This paper reports laboratory work in which numerous compounds were mixed with lead arsenate and applied to apples as a combination spray. The fruit sprayed with the various combinations was then treated with acid to learn what material aided the solvent action of the acid.

The Ratio of Sulphur to Phosphorus in Western Soils and Losses of Sulphur Through Drainage and Cropping, J. S. Jones in *Soil Science,* Vol. 26, December 1928.

Recent completion of a soil survey of an extensive area in northwestern Oregon, widely known as the Willamette Valley, brings to light additional facts regarding the sulfur to phosphorus ratio in cultivated soils. Analytical data on eastern and middle western soils seem to warrant statements to the effect that sulfur and phosphorus are present in the soil in practically identical amounts. This generalization cannot be accepted for the Pacific Northwest. A number of years ago the ratio of sulfur to phosphorus in soils of the Rogue River Valley—a region of low rainfall in Southern Oregon—was found to be approximately as 1 is to 2.3. This later work in the Willamette Valley, where annual rainfall approximates forty inches, indicates a sulfur to phosphorus ratio almost twice as wide. The difference between soils of eastern and middle western sections and those of the Pacific Northwest in the matter of sulfur and phosphorus lies not in the lower sulfur content of those on the Pacific Coast but in their higher phosphorus content. The study of lysimeter tank percolates, drainage water, and of annual crop requirements for sulfur and phosphorus, leads to the conclusion that the ratio of sulfur to phosphorus in Willamette Valley soil must continue to widen, and herein lie substantial reasons for the importance attached to sulfur in fertilizer practice in this particular section of the Northwest.

Some Observations on the Microchemical Determination of Phloridzin, E. M. Harvey in *Plant Physiology,* July 1929.

This article reports the results of the search for, and the application of, microchemical tests for phloridzin in apple tissues. Several hundred substances or combinations were tried. Of all these substances, ferric chloride, uranium acetate and aluminum nitrate seemed to be the most satisfactory. The application of these reagents showed that phloridzin is most abundant in the phloem, particularly the phloem of leaf traces, abundant in the outer cortex, or inner periderm, but rather scarce in the inner cortex, except at the nodes around the leaf traces, and if it does not occur in the cambium, it occurs very close to it. At the beginning of growth activity in the spring, when buds are swelling, the bases of axillary and terminal buds are gorged with phloridzin. The inner bud scales and the peduncles, receptacles and styles of the embryonic flowers are also gorged with it. The conclusion was drawn that phloridzin is localized and most abundant in, or in close proximity to the most active tissue.

The Fourth Pacific Science Congress, E. M. Harvey in *Plant Physiology,* January 1930.

A report giving a brief description of the organization of the Fourth Pacific Science Congress, the scientific excursion through Java; and the accounts of the papers presented at the meetings.

Hybrids Between Pyrus Malus and Pyrus Fusea, Henry Hartman in *Journal of Heredity,* Vol. XX No. 8, August 1929.

This publication calls attention to the hybrids of *P. malus* and *P. fusea,* which are quite common in the region west of the Cascade Mountains in Oregon and Washington. These hybrids occur in the wild, and some artificial crosses have been made by the Oregon Experiment Station.

They offer possibility, if there should come a time when new varieties of crab-apples are again in demand.

The Stick Method of Cutaneous Virus Vaccination Against Fowl-pox, W. T. Johnson in *Journal of American Veterinary Medical Association,* November 1929.

A highly satisfactory method of cutaneous virus vaccination for the control of fowl-pox, called the stick method, is described. It is briefly compared with the scarification and follicle methods. The method has been applied almost exclusively to the common domestic fowl but its limited use on turkeys is also considered. The small amount of virus used, rapidity of application, and uniformity of takes especially commend it. The success of the method hinges on the use of a highly potent virus, concerning which information is given as to its preparation and care. Such phases as when to vaccinate, examination for takes, after-effects, development and duration of immunity, sale of vaccinated fowls, and demonstrating the effectiveness of vaccination are discussed.

TECHNICAL PAPERS

Irrigation by Pumping, W. L. Powers and quoted. *Oregonian.*

Recent Developments in Drainage, W. L. Powers in *Oregon Farmer.*

Alkali Land Reclamation with Sulfur, W. L. Powers in *California Cultivator.*

Sulfur for Alfalfa, W. L. Powers in *California Cultivator.*

Lime in Relation to Permanent Agriculture, W. L. Powers in *Oregon Farmer.*

Progress of Reclamation in Oregon, W. L. Powers, in *Triennial Report, Oregon Reclamation Congress.* 1928. Also published in *Hydraulic Engineer.*

A State and National Program of Land Use, W. L. Powers in *Oregon Farmer.*

Effects of Sulfur and Sulfate in Alkali Land Reclamation, W. L. Powers in *Oregon Farmer,* September 1929.

Soil Fertility as Related to Irrigation Requirements, W. L. Powers in *Oregon Farmer.* Also issued in mimeographed form.

Opportunities in Reclamation, W. L. Powers in *Hydraulic Engineer,* April 1929.

Recent Developments in Fertilizer Practice, W. L. Powers. Address at N. W. Fertilizer Association, Wenatchee, July 1929.

Irrigation of Summer Pastures, W. L. Powers, in *Oregon Farmer,* October 1929. Also issued in mimeographed form.

Green Manuring for Soil Improvement, W. L. Powers in *Pacific Homestead,* April 1930.

Use of Phosphorus on Oregon Soils, W. L. Powers in *Oregon Farmer.*

Drainage by Means of Wells, M. R. Lewis. Read at Oregon Reclamation Congress.

Wet Soil Types of Willamette and Their Use, W. L. Powers. Read at Oregon Reclamation Congress.

The Farm Homemaker's Job, Maud Wilson in *Rural America.*

This includes the main points brought out by the investigation on Use of Time by Oregon Farm Homemakers, especially those which were thought to be of interest to the student of rural sociology—the job in relation to conditions of labor; its cycles; the suggested connection between conditions of labor for the homemaker and standards of living for the family; comparison with the job of the woman not living on a farm; leisure activities in relation to conditions of labor.

Laundry Time Costs, Maud Wilson in *Journal of Home Economics.*

This article aims to supply factual material to teachers and students of home economics as to the time given to laundry work in households of various sizes, and its relation to the total time costs of household operation. Variations were noted which were associated with the use of paid help and laundry equipment available. Other points noted were the extent of the use of commercial laundries, and the relation between fatigue from laundry work and equipment used.

The European Walnut Aphis, a New Pest in the United States, *Journal of Economic Entomology,* Vol. 22, No. 1:22.

The dusky-veined walnut aphid, *Callipterus juglandis* Frisch, not heretofore recorded from the United States, was found damaging walnuts in the Willamette Valley during the summer of 1928. This aphis is much larger than the ordinary walnut aphis and works entirely along the midrib on the upper surface of the leaf. A 2 percent nicotine dust was found to be an effective control.

Moths of the Family Aegeriidae Occurring in Oregon With Notes, *Pan-Pacific Entomologist,* Vol. 5, No. 3:117-122.

Reference is made to recent publications on species of this family occurring in Oregon as well as to the original descriptions of species known to occur in the state. The host plants are also given when known. Twenty species of the family are recorded as occurring in Oregon. Of these, the author has collected seventeen. Many of the species occurring in the state are pests of major importance. The Western peach and prune root-borer so prevalent and so destructive to our peach and prune plantings belong to this group, as does also the loganberry crown moth, the strawberry crown borer and many other important pests of forest and orchard.

The Nut Insects of Oregon, B. G. Thompson in *Annual Report of the Oregon State Horticultural Society,* 1929.

A list of nut insects known to occur in Oregon is given with a description of the insect and the injury. Control measures are given when known. The walnut husk maggot, an insect not yet known to occur in Oregon, is described and its injury and distribution noted.

Dusting for the Codling Moth Control in the Willamette Valley, 1927-28, B. G. Thompson in *Journal of Economic Entomology,* 1929, Vol. 22, No. 6:934-936.

The experimental work at Oaco orchards shows that in this locality lead arsenate dust and calcium arsenate dust, when applied under favorable conditions, are effective in controlling the codling-moth. As these results are more favorable than obtained elsewhere in the Northwest by other workers, local conditions may have an important influence on them.

The Strawberry Crown Moth in Oregon, J. Wilcox, D. C. Mote and O. A. Hills in *Journal of Economic Entomology,* Vol. 22, No. 6:936-943, December 1929.

This article is a technical discussion and report of the results of the crown borer project in the 1928 season and preliminary observations of the 1927 season. The outstanding data reported were the place of oviposition and the habits of the newly hatched larva in entering the plant.

The Strawberry Root-Weevils, J. Wilcox in *Monthly Bulletin California Department of Agriculture,* Vol. XIX, No. 3-4, March-April 1930, p. 227-230.

A brief description of each species is given together with the methods of telling the various species apart. The host plants and distribution of these weevils in the world is given so far as is known. Methods by which these insects might be transported from place to place are discussed together with suggestions as to how they might be intercepted in transit.

The Cherry Fruit Fly in Oregon, D. C. Mote in *Monthly Bulletin California Department of Agriculture.*

Dealing with the known life habits and control of this pest in Oregon.

Reproductive System of the Warbly Fly, Hypodermia bovis DeGeer, D. C. Mote in *Annals of the Entomological Society of America,* Vol. 22, No. 1:70-81, March 1929.

A morphological study of the male and female genitalis which are used as a basis for classification of many diptera.

Some Preliminary Experiments on the Control of Bacterial Blight of Walnuts Conducted in Oregon in 1929, H. P. Barss in *21st Annual Report Oregon State Horticultural Society.* 1930.

This article reports the value of bordeaux mixture as applied by growers under the direction of the Station for the prevention of walnut blight. The presence of spray injury is also noted. Growers are cautioned against employing the method generally until further tests have indicated whether or not such injury can be avoided or minimized.

Hysterangium in North America, S. M. Zeller (with C. W. Dodge of Harvard University) in *Annals Missouri Botanical Gardens,* 16:83-128. illus. February 1929.

This monograph lists with full description 31 recognized and 2 doubtful species of Hysterangium as well as 3 species which are excluded. Nineteen of the accepted species are North American. Seven species are described as new to science. A Key to all known species is included.

Contributions to Our Knowledge of Oregon Fungi, 111, S. M. Zeller in *Mycologia* 21:97-111. illus. March 1929.

This paper lists with notes 119 fungi which have not previously been reported from Oregon. Of these *Clavaria occidentalis* and *Phymatotrichum fungicola* are described as new, and *Lepiota decorata* is newly named. The toxic effects of the poisonous mushroom, *Amanita pantherina* are described.

Another Anthracnose of Raspberry, S. M. Zeller in *Phytopathology,* 19:601-603. illus. June 1929.

In western Oregon and Washington, an anthracnose caused by *Gloeosporium allantosporum* occurs on the wild black raspberry (*Rubus leucodermis*) and on cultivated varieties of black raspberry and the St. Regis variety of red raspberry when the latter are planted near the wild host harboring the disease. The disease is briefly described. Bordeaux 4-4-50 applied just before the discharge of spores in the fall has controlled the disease on canes grown during the current season.

Observations on Armillaria Root Rot of Orchard Trees, Leroy Childs and S. M. Zeller in *Phytopathology* 19:869-873. illus. September 1929.

This paper presents the histories and observations on typical cases of *Armillaria mellea* on roots of orchard trees planted on (1) fir-cleared land, and (2) oak-cleared land. There is evidence of two distinct physiologic strains of the fungus. The oak strain is parasitic, while the fir strain apparently is not.

Yellow Rust and Cane Blight of Red Raspberry in Oregon, S. M. Zeller in *Better Fruit* 24 (7). January 1930.

This paper describes the destructive basal canker of red raspberry recently appearing in the Willamette Valley, which has been found to be caused by a combined action of the yellow rust and cane blight diseases in which the fungus causing the latter invades lesions on the canes which were initiated by the rust. Control measures suggested include complete sanitation by removal of old stubs and canes, followed by plowing toward the rows late in the fall, after the leaves have all dropped, in order to cover up these sources of spring infection.

Some Species of Atropellis and Scleroderris on Conifers in the Pacific Northwest, S. M. Zeller and L. N. Goodding (in press), in *Phytopathology,* July 1930.

This paper describes as new to science two fungi and reports their distribution and economic importance. One of them (*Atropellis pinicola*) is associated with a canker of western white pine, lodge-pole pine, and sugar pine, while the other (*Scleroderris abieticola*) is associated with the firs (*Abies grandis* and *A. amabilis*). A fungus found on the Sitka spruce is referred to the genus *Atropellis* as *A. treleasei.*

Outlook for the Culture of Some Flowering Bulbs in Western Oregon, M. B. McKay in *20th Annual Report of the Oregon State Horticultural Society,* 179-192. 1929.

This article is a general discussion of the problems of commercial bulb production in the state. Narcissus, bulbous iris, tulip, lily, hyacinth, and gladiolus receive consideration. General directions are given for bulb treatments and a discussion of diseases commonly found on these plants is included.

Shaping Young Walnuts and Filberts, W. S. Brown in *20th Annual Report Oregon State Horticultural Society.*

Oregon State Agricultural College and Oregon's Horticulture, W. S. Brown in *20th Annual Report Oregon State Horticultural Society.*

Experiments with Perfume Roses, W. S. Brown, paper read at meeting of 12th annual Northwest Horticulturists, Entomologists and Plant Pathologists.

Grading Prunes for Quality, E. H. Wiegand, Oregon State Horticultural Society, Eugene, June 7, 1930. This paper will appear in the report of the Society.

History of Oregon Apple Prices, R. S. Besse in *Oregon State Horticultural Society Report,* 1928.

Improvement of Efficiency in Western Hay Making Methods, H. E. Selby, before American Society of Agricultural Engineers, 1929.

Development of Methods of Appraising Agricultural Lands, H. D. Scudder before State Bankers' Association, 1929.

Factors Controlling Cost of Prune Production in Oregon, H. D. Scudder in *Oregon State Horticultural Society Report,* 1929.

Incomes from Oregon Farming, H. D. Scudder before State Smith-Hughes Convention, 1929.

Costs and Profits in Commercial Egg Production in Oregon, H. D. Scudder before State Poultrymen's Association, 1929.

Perspectives on Values Derived from Agricultural Cost Investigations, H. D. Scudder before Western Farm Economics Association, Logan, Utah, 1930.

Costs and Returns of Pear Production in the Rogue River Valley, R. S. Besse in *Oregon State Horticultural Society Report,* 1930.

The Problem of Arsenical Residues, Leroy Childs. Presented before Fourth International Congress of Entomology, Ithaca, August, 1928.

The situation in different apple-growing areas and results of investigations relative to the production of apples to meet market requirements.

Spider Mites and Their Control, Leroy Childs. Oregon Horticultural Society, Medford, Oregon. November 1929. (In press.)

Pollination of the Anjou Pear, Leroy Childs and Gordon G. Brown, Oregon Horticultural Society, Medford, Oregon. November 1929. (In press.)

Notes on the Introduction of the Woolly Apple Aphis Parasite, Aphelinus mali, Leroy Childs and D. G. Gillespie, before Pacific Division, American Association for the Advancement of Science, Eugene, Ore. June 1930. (Published in *Journal of Economic Entomology,* Vol. 23, No. 4, August 1930.)

Nicotine in Paint for Woolly Aphis Control, Leroy Childs.

To appear in *Journal of Economic Entomology,* Vol. 23, No. 4. August 1930.

SERVICE

THE Station, constituting a clinic and an information bureau, renders a service of great value to the state in response to calls for personal interviews; letters in reply to requests for technical and other information; identification of insect, plant, and animal diseases; the analyses of soils, fertilizers, milk and water specimens; and the giving of information in conferences, addresses, and radio talks.

This service is in addition to the accumulation of facts through research and experimentation and the solution of problems concerning agriculture and rural life which constitute the primary function of the Experiment Station. This service in the main is rendered in cooperation with the Extension Service and resident teaching and is jointly financed. Following is a careful estimate of such activities for *one year,* which is a fair average for each of the past few years.

1.	Letters in reply to requests for information	30,912
2.	Consultations with individuals seeking information	9,537
3.	Identification of plant specimens	2,665
4.	Identification of insect specimens	1,550
5.	Identification of other material	900
6.	Tests for infectious abortion in dairy cattle	47,500
7.	Tests for bacillary diarrhea in poultry	85,000
8.	Disease identification	1,055
9.	Germination and purity tests of seed	3,813
10.	Purity tests of milk	4,800
11.	Purity tests of water	1,000
12.	Soil analyses and identifications	400
13.	Chicken-pox vaccine distribution (doses)	92,000
14.	Legume cultures distributed for (acres)	13,000
15.	Samples of fertilizers analyzed	100
16.	Economic poison analyses	136
17.	Miscellaneous chemical analyses	250
18.	Miscellaneous bacterial analyses	250
19.	Number of station exhibits	12
20.	Butter scored for molds and yeasts (samples)	500
21.	Chemical analyses of butter (samples)	500
22.	Farmer visitors	3,350
23.	Radio talks	256
24.	Addresses made	253
25.	Popular articles and press notices	215
26.	Pumping plants and irrigation systems designed	60
27.	Blue prints of dehydrators distributed	78
28.	Pressure test determinations for fruit maturity	125
29.	Samples of canned fruit, vegetables, fresh meat and other articles examined for spoilage	62

STATION FIELD DAYS

RESULTS and progress of certain experimental work are brought to public attention with special effectiveness through the medium of Station Field Days. During the biennium station field days were held at all the branch stations. A number of field days were held at the Central Station. The nature of these meetings and the number of farmers they served is indicated by the following examples.

Character of Meeting	*Place*	*Attendance*
Irrigation Field Day	Central Station	270
Alkali Experiment Field	Vale, Oregon	100
Drainage Field Tour	Central Station	60
Irrigation Well Field Demonstration	Sam Brown's Farm	600
Irrigated Pasture Field Days	Central Station	850
Irrigated Fruit and New Varieties of Strawberries	Central Station	150
Irrigated Vegetables	Kiger Island	75
Bulbs and Small Fruits	Central Station	50
Small Fruits Field Day	Central Station	100
Narcissus Field Day	Central Station	50
Root Crop Field Day	Astoria Station	100
Astoria Station Field Day for Columbia county	Astoria Station	50
Astoria Station Field Day for Tillamook county	Astoria Station	50
Astoria Station Field Day for Clatsop county	Astoria	100
Burns Branch Station Field Day	Burns	300
Field Days by the Branch Station	Moro	600

EXHIBITS

STATION accomplishments and activities were presented to the public through exhibits at the State Fair and at the Pacific International Livestock Exposition in 1928. Because of the shortage of funds for maintaining important investigations, however, no Station exhibits were presented in 1929. Only limited exhibits, if any, will be undertaken in 1930.

REGULATORY

THE Station staff administered the State Fertilizer Inspection Law, the Lime Law, the Insecticide and Fungicide Law, the Dairy Bull Registration Law, and the Stallion Registration Law. Valuable service is rendered in this connection at comparatively small expense, by using the background of Station facts and trained staff members when they are needed, without duplicating overhead expense.

ADDITIONAL INVESTIGATIONS REQUESTED FOR BIENNIUM

DESPITE the fact that the Experiment Station during the biennium undertook the solution of a greater number of problems than for any other biennium, more requests for additional investigations were received than for any similar period since its organization. These new requests include many investigations to develop control methods of plant and animal diseases and pests. They include also widely distributed problems of production and deal with the perplexing problems of irrigation, drainage, economic surveys, and cost of production studies more or less state-wide in character and scope.

The number of these investigations, all important and seriously needed, is much greater than available funds can care for; and although work on some new projects has been started during the biennium, the majority of these problems will be compelled to await solution until funds and facilities are made available through additional appropriations or after completion of investigations now under way.

PLANT DISEASE AND INSECT PEST PROBLEMS

Losses in excess of $4,000,000 annually are caused by the ravages of uncontrolled insect pests and diseases of Oregon crops. Growers suffering these losses have made repeated requests for investigations to develop methods of control. The following summary indicates the character of these requests.

Vegetable and truck crops—

1. Investigations to control the 12-spotted cucumber beetle, which at times practically ruins the bean crop for canning in sections of the state as well as causing serious damage to other vegetable, fruit, and field crops. Work has been started on this project in a limited way.

2. Investigations to determine life habit of the garden symphilid and devise control methods. This pest is responsible for the destruction of vegetable crops, feeding on the roots and preventing growth. It has caused serious loss. Many requests for studies of this pest have been received.

3. Investigations to develop a mold-resistant tomato variety for greenhouse propagation. Mold is the most serious trouble affecting fall-grown tomatoes.

4. Scientific tests of a newly invented method for the control of damping off disease of vegetables, one of the most perplexing problems of the vegetable industry.

Fruit crops—

1. Investigations to control the pear-bloom wilt, which prevents fruiting and causes serious loss.

2. Investigations to work out control of the raspberry fruit worm which is a serious menace to the canning industry causing condemnation of an infested pack.

3. Investigations to determine cause and method of control of fruit spot outbreak which occurred in Eastern Oregon in 1929, causing serious damage in individual orchards.

4. Investigations to develop methods of spraying and dusting orchard fruits for more effective insect and disease control with less injury to the fruit. Losses due to fruit blemishes induced by ordinary sprays on sensitive-skinned varieties amount to thousands of dollars annually.

5. Investigations of the effect of fungicides on the keeping quality of Italian prunes and sweet cherries. Enormous losses are sustained in many years by the development of brown rot after picking.

6. Investigation of cherry-bud blight in the central Willamette Valley, responsible for the ruin of a number of previously profitable orchards.

7. Study of cause and control of a new, seriously defoliating leaf spot of apples in Southern Oregon.

8. Investigation of so-called "little leaf" disease of stone fruits which constitutes a serious problem in the Wasco county area.

9. Investigation of "yellow leaf" of peach in Baker county.

10. Investigations of an unknown fruit-pitting disease of Bosc pears in Southern Oregon.

11. Further studies in the control of American and European brown rot, which continue to be the most serious disease problems of cherries and prunes in Western Oregon.

12. Investigations to work out the control of the syneta fruit beetle, which attacks fruit of cherries, apples and pears, causing heavy losses to Oregon fruit growers.

13. Investigations for control of red spider on pear, prune, cherry and other hosts. This pest feeds on leaves, devitalizing the trees and preventing fruiting.

14. Investigations of the life-history and control methods of the rusty leaf mite. A pest about which little is known.

15. Investigations to develop control measures for the lace bug, which made a severe attack on apple orchards in two districts in 1930. The known contact sprays were ineffective against this insect.

16. Investigation for control of mite on blackberries. This pest caused a loss of at least $25,000 in one berry growing district in 1930.

Field crops—

1. Investigations to control rust in the oat crop. In some years this disease causes loss of entire crop in Coast Sections.

2. Investigations to control a disease of wheat known as foot rot, which may cause falling of almost the entire crop in certain Eastern Oregon localities. A cooperative project is now under way with the Federal Department of Agriculture.

3. Investigations for determining methods of controlling grain weevils in the Portland docks. Some preliminary work has been done.

4. Investigations of the downy mildew disease, the world's worst hop disease which in 1930 appeared in Oregon's 17,000 acres of hop fields, threatening an industry that brings in to the state an annual gross income of $3,000,000 to $4,000,000.

5. Investigation of bacterial wilt and root rot of alfalfa, which was reported from Oregon for the first time in 1929 and constitutes a menace to the alfalfa crop.

6. Investigation of nematode disease of common crops, including alfalfa, clover, strawberries, teasels, potatoes, and bulbs.

7. Investigation of blackleg disease of potatoes increasing in Klamath county and other sections.

8. Investigations to work out control methods for watermelon wilt, the chief disease problem of watermelon production in the state.

9. Studies of the stem rot disease of alfalfa and clover, which is destructive in some seasons.

10. Investigations of the mold disease of hops, which appears usually at picking time.

11. Investigations for control of pea-weevil, which is a limiting factor in the production of the Austrian Field Pea in Oregon.

12. Investigations to work out control of cherry fruit-fly, which causes the condemnation of all packs of fruit in which fruit-fly maggot is found.

13. Investigations to develop control methods for corn ear worms and insect pests of greenhouse and flower gardens.

Nursery, ornamental and nut crops—

1. Investigations to work out the control of insect pests and plant diseases of nursery crops. Heavy losses have resulted from the work of the root weevil which alone destroys thousands of azalea plants and conifer nursery trees.

2. Investigations to work out further control of the rose mosaic, which reduces the demand for western rose stocks among eastern florists to an extent ruinous to the rapidly growing industry. Some work is now being done on this disease, but requests for further assistance are coming to the Station.

3. Investigations to work out control methods for chestnut weevils.

4. Investigations of nut blight and stain. In 1928 this disease destroyed half of the crop in some groves. The cause is unknown.

5. Investigations to work out control methods for aster wilt and develop resistant varieties, a serious menace to the aster seed industry.

6. Studies of a new filbert weevil heretofore never found in the filbert nut in Oregon. The potential damage of this weevil is still unknown. Losses in Europe from a similar weevil range from 25 to 50 percent.

7. Studies of a new iris and strawberry pest, which destroys every iris flower it attacks. It also feeds in the fruit of the strawberry.

Miscellaneous crops—

1. Investigations to control wireworms on newly drained land. These worms are responsible for the loss of the entire bean crop on approximately 80 acres in 1929.

2. Investigations to determine methods of controlling mosquitoes.

3. Investigations of new and promising insecticides, including derisol, pyrethrum, pine tar oil, petroleum oils, and many other insecticides.

4. Investigations of the insects which transmit virus and the mosaic diseases.

ANIMAL DIESASE PROBLEMS

The uncontrolled diseases of sheep, poultry, cattle, and hogs are responsible for an estimated loss of more than $2,000,000 annually to the livestock industry of the state. Urgent requests for assistance in checking these losses have been received from all sections.

For example, Oregon's $15,000,000 sheep and wool industry has made repeated calls for investigations to determine cause for losses and develop methods of control. The estimated loss, due largely to preventable causes, is approximately $1,400,000 annually. Although some work has been done to reduce these heavy losses, and recent investigations of liver flukes and lung worms have made encouraging progress, the sheep disease problems, in the main, have been merely touched, and urgent requests have been received for additional investigations covering the following problems.

Sheep—

1. Lamb dysentery, which is a new disease in Oregon, reported in Montana for several years, where it has become a serious problem.

2. Infectious abortion in sheep, reported in three Oregon counties and a serious problem in some sections.

3. Infectious inflammation of the eyes of sheep.

4. Pregnant ewe disease, an undiagnosed trouble causing heavy losses.

5. Lip and leg ulcers, a disease of long standing.

6. Stiff lambs. In certain districts 2½ to 5 percent of lambs affected and loss is heavy.

7. Lung diseases of sheep.

8. Ewe paralysis found in all parts of the state and affecting from 1 to 2 percent of the total ewe population.

9. Foot rot of sheep found in all parts of the state.

Many unsolved problems in controlling the diseases of cattle, poultry, and turkeys need attention, and growers engaged in these enterprises have asked for further investigations as follows:

Cattle—

10. Scours, which is an acute infectious disease, appearing first in the coast counties, and has now become prevalent in all of Western Oregon.

11. Investigations to diagnose unknown diseases of cattle and horses in Eastern Oregon. A cooperative project has been developed and some work done.

12. Forage poisoning in hay.

13. Investigations to determine cause of sterility in heifers and to develop means of control.

Poultry and turkeys—

14. Various diseases of turkeys.

15. Range paralysis in poultry, which is one of the serious problems of the industry, appearing in every section of the state.

16. Infectious bronchitis of poultry. This disease is not present in Oregon at this time, although outbreaks have been diagnosed. The disease threatens to cause very heavy losses if it becomes widespread in the state.

17. Tapeworm in poultry.

18. Investigations to determine the effect of feed on color of egg yolk. Some work has been done on this project, but much further work is necessary.

19. Investigations to work out the comparative values of salmon oil, salmon meat, and dog-fish oil compared with cod-liver oil in rations for chickens.

Fish and game—

20. Diseases of mink raised in captivity. Growers in both Eastern Oregon and the Coast counties have asked for these investigations.

21. Causes of death losses in fish. The state game commission has requested information concerning the rather heavy losses which have occurred in the young fish at one of the fish hatcheries.

OTHER PROBLEMS

Requests for investigations of other perplexing problems having a definite economic bearing on agricultural development, have been received from all sections of the state as indicated by the following examples—

Drainage and irrigation—

1. Investigations of underground water supply in Wasco county and in the Harney Valley. A cooperative project with the U. S. Geological Survey has been undertaken.

2. Drainage and irrigation problems in Jackson county. This work has been started in cooperation with the U. S. Bureau of Public Roads and Jackson county.

3. Drainage and pumping for irrigation in Baker Valley. Some work has been done on this project. The investigation will be continued in cooperation with the U. S. Bureau of Public Roads, Division of Agricultural Engineering.

4. Survey of overflow lands in the Coquille Valley. A cooperative project was undertaken with the Bureau of Public Roads, Division of Agricultural Engineering, and Marshfield Chamber of Commerce.

5. Drainage of pear lands in the Grants Pass district.

Economic studies and soil surveys—

1. Economic survey in Scappoose Drainage District to determine productive value and economic utilization of land. Work on this project has been undertaken.

2. Economic survey of newly drained lake-bottom bed.

3. Soil survey, Baker county.

4. Cost and efficiency studies in honey, turkey, raspberry, cherry, broccoli, and filbert production.

Processing and marketing—

1. Technical assistance in packing and brining cherries for maraschino purposes. A project has been outlined and some work done during the biennium.

2. Investigations concerning the retting of flax.

3. Milling and baking investigations.

4. Investigations to determine method of improving the quality of butter and to aid in standardizing the manufacture of butter.

5. Industrial studies to determine feasibility of undertaking cooperative marketing and to guide farmers in the readjustment of agricultural production to meet changing economic conditions.

6. Investigations of the cooperative movement, including need for locals and the legal set-up and financial status and requirements of cooperatives desiring financial assistance from the Federal Farm Board.

7. Study of economic feasibility of storing wheat on farms and issuing warehouse receipts against such holdings.

8. Study of cooperative contracts with a view to improving contractual relationship between the cooperative and the grower.

9. Cold storage investigations of fruits, vegetables, canned goods and fresh packed fruit.

10. Studies in the removal of spray residues from cherries intended for fresh fruit shipment.

11. Investigations into the factors which cause great variability in quality of canned squash.

Fertility and production—

1. Investigations of the use of chlorates in weed control. Preliminary investigations indicate that chlorates are promising herbicides for perennial weeds. Further study is desirable to determine cause of variation in results in different parts of the state.

2. Investigations to test new tillage implements and results of different methods of cultivating land.

3. Cooperative trials with cereals, grasses, and fiber flax.

4. Investigations of transpiration and other water relations in horticultural plant and root growth.

5. Investigations of varieties and methods of propagating blueberries and the determination of soils suitable to this crop.

6. Investigations relative to the growing and harvesting of tomatoes, melons, egg plant, peppers, asparagus, watermelons and lettuce.

7. Studies of the influence of fertilizers and methods of soil management on production, color, keeping quality and dessert quality in pears.

8. Studies of the influence of nitrogen on the keeping quality of apples.

9. Permanent orchard soil culture and fertility investigations in the Rogue River Valley.

Miscellaneous—

1. Seed investigations.

2. Requests for the establishment of branch stations in Multnomah, Douglas, Yamhill, and Clackamas counties.

3. Milk surveys in cities to determine bacterial count.

4. Hay-fever pollen survey and manual for Oregon as an aid to the physicians and hay-fever sufferers of the state.

URGENT NEEDS OF THE STATION

NEED for additional land, storage and greenhouse facilities, office and laboratory space, and modern equipment becomes more urgent each year as the agricultural problems requiring investigation increase in number and scope.

LAND NEED IMPERATIVE

The need for additional land for experimental purposes is urgent and is becoming more pronounced each year.

The situation was somewhat relieved in 1929 by the purchase of 124 acres of brown valley floor soil known as the Strader place and the rental with option to purchase of the Buchner place, consisting of 118 acres. The expansion of the campus westward, however, has taken over crop rotation experiments and field crop experiments which had been under way for many years, thus necessitating the transfer of these investigations to other lands.

The pressing need for additional land and for the purchase of land now leased by the Station is indicated as follows:

1. Western Oregon agriculture is made up of many commercial agricultural enterprises, each having problems of production and protection against diseases and insects.

2. The increasing demand for work on problems of crop production involving seed, pasture, forage, grain, fruit, nut, vegetable and bulb crops requires more land than is now available.

3. The efficient handling of the problems of rotation, soil fertility, irrigation and drainage, requires the use of additional land.

4. Much of the basic research for other sections of the state involving experimental land must be done at the Central Station to avoid duplication of laboratories.

5. An increasing amount of Federal cooperation in research involving land needs has its base at Corvallis.

6. There are at least three major soil types which must be studied.

7. Long time experiments cannot be properly undertaken on land not owned by the Station because—

a. Effective experiments with crop and soil problems require continuous records over long periods of time on the same soils. This cannot be assured on rented land.

b. The knowledge of the soil reactions and treatments gained through years of operation on the rented lands is lost when such lands are transferred to other hands.

c. The leasing of land for experimental purposes is both unsatisfactory and uneconomical and can be considered only as a temporary arrangement.

To meet this need the Station now has available 1,231 acres of which 292 acres are owned and 939 acres are leased land. The Central Station needs a minimum of about 1,900 acres of owned land.

The present owned land for experimental work is meager as compared with 500 acres at Washington State College, 600 acres at Idaho, 600 acres at Colorado, 1,400 acres at Kansas State College, and approximately 2,000 acres at Purdue.

STORAGE FACILITIES

Refrigeration. More adequate cold storage facilities especially designed and constructed for research work are needed for those problems which require controlled temperatures involving—

1. Storing, processing, and marketing of perishable crops.
2. Studies of plant growth and propagation.
3. Research for animal products.

The present refrigeration facilities are inadequate properly to handle these problems, being limited to—

1. A small unit for Poultry and Veterinary Medicine.
2. A cold storage unit for dairy products.
3. Cold room facilities for Horticulture.

Common storage. Open sheds, barn room corners, ground-floor basements and other temporary and makeshift storage facilities are inadequate, inefficient, and uneconomical for the storage of valuable experimental seed stocks, and materials which have been accumulated at heavy cost over a period of years and which involve the continuation of important research problems. The results of important experiments are constantly endangered by such unsuitable storage accommodations. This condition is not consistent with sound business management and emphasizes the pronounced need for more ample and satisfactory common storage space.

Automobiles and machinery constituting essential equipment for many research problems require suitable storage to prevent rapid depreciation when not in use. Only temporary shelter is now available, every nook and corner being utilized for this purpose. The payment of garage rental is necessary for several of the station cars to provide sufficient storage space. There is a real need for more adequate storage facilities for farm machinery and automobiles.

ADDITIONAL OFFICE AND LABORATORY SPACE NEEDED

There is a most urgent need for additional office and laboratory facilities for conducting effective research work, as indicated by the following points:

1. The expansion of office and laboratory facilities has not kept pace with the increase in research problems. With the exception of the Poul-

try-Veterinary Building, approximately the same space is now occupied by the Station staff as was utilized ten years ago when the staff was about one-third its present size and investigational work was not as highly developed.

2. The heavier demand for investigations.

3. The larger number of research problems undertaken. These problems have increased manyfold during the past ten years.

4. The large increase in Federal cooperative investigations, involving the use of laboratories and office space by Federal representatives.

As far as practicable, research men should have desks away from confusion and distraction which prevent the concentration necessary to effective work. The following examples serve to illustrate an undesirable condition caused by the present lack of space.

1. Botany and Plant Pathology has five staff members with offices in one laboratory and four others have their office desks in one combination laboratory, storage, and photograph room.

2. Entomology has ten men in one room, used for research workers and advanced students and for spray mixing laboratory. Four others are in another combination office and laboratory.

3. The Director and assistant to the Director share an office together in a room approximately 8 x 20 feet, with one window. This limited space serves as a combined work room and headquarters for the administration of all Agricultural Experiment Station activities, including the research of 14 central departments, 8 branch stations and many federal cooperative investigations, which altogether are working on approximately 400 different research problems. In this inadequate space, moreover, visitors are received, conferences and consultations are held, and the research program is developed and supervised.

A second small room is available for the secretary, the stenographer and clerk, for temporary help, and for office files and financial records.

The condition with respect to research laboratory space is as unsatisfactory as it is for office space. With the exception of Poultry and Veterinary, the laboratories are outgrown and in many ways unsuitable for research. They represent space designed for other purposes and later converted into research laboratories.

Farm Crops must use mainly student laboratory space for laboratory study of grain, forage, and roots. There is no milling and baking laboratory.

Entomology is crowded with six to eight men in laboratory space about adequate for three.

Animal Husbandry is practically without modern laboratory space for research with meat and other animal products.

Botany and Agricultural Chemistry are in need of more laboratory facilities of modern type.

Additional space to a minimum of 4,400 square feet is imperative within the next biennium for Botany, Entomology, and Horticulture to provide for investigations which will probably be arranged for in connection with hop mildew, pea-weevil, and other emergency problems.

GREENHOUSES

The 6,600 square feet of greenhouse space made available for Station work by the erection of the new greenhouse during the last biennium is already insufficient to provide adequate space for important investigations under way. Construction during the fall of 1930 of additional units approximating 5,000 additional square feet of space has been approved to provide for cooperative investigations with the United States Department of Agriculture. The field work of these cooperative investigations is already under way.

In order to provide adequate facilities for greenhouse investigations which it is the responsibility of the Experiment Station to perform, an increase in greenhouse space of at least one unit of 1,100 square feet each year will be needed until a total of 20,000 square feet of space is available.

EQUIPMENT

There is need for approximately $35,000 worth of additional equipment and scientific apparatus now for efficiently conducted research work in the fifteen departments of the Central Station and for double this amount over the next ten-year period, according to an equipment survey made during the past eight months.

Research in all fields of agricultural science requires modern equipment with reasonably prompt replacement of obsolete or worn out apparatus. Much of the present equipment available is now antiquated, inefficient, or worn out. Equipment additions have not kept pace with the growth of the agricultural industry nor with the research problems presented by these industries.

As long as the need of research on new and old troublesome problems continues as urgent as at present only a minimum of equipment for major research problems undertaken will be purchased. Even under such policy, however, equipment purchases must be increased somewhat compared with past years.

PROGRESS AND RESULTS OF INVESTIGATIONS UNDER WAY — BY DEPARTMENTS

BRIEF statements of the work, progress, and results of the main investigations undertaken during the biennium by the fifteen departments of the Central Station and the eight branch experiment stations are presented in the following pages. The respective reports are given by projects.

DEPARTMENT OF AGRICULTURAL CHEMISTRY

INSECTICIDES AND FUNGICIDES

The list of garden, orchard, and field crops that require more or less protection against the ravages of insect pests and fungous diseases is steadily growing. Constant vigilance on the part of this department is necessary to insure thorough acquaintance and contact with up-to-date developments in the manufacture and use of insecticides and fungicides. Growers must be warned of the ineffective and useless materials and guided in their use of old and new remedies to maintain control of the situation. Specifically, attention has been centered on the following:

Mineral-oil emulsions. The importance of mineral-oil emulsions in the spray program is unquestioned. There is room, however, for considerable improvement in the matter of adaptation to the various uses made of them. Heretofore it has been assumed that calyx injury to light-colored apples following the use of mineral-oil emulsion is the result of too large a concentration of "unsaturated" compounds in the oils used. Efforts have been made to obtain for spray purposes oils whose content of unsaturated compounds has been reduced to a very low percentage by refining processes. The interpretation and correlation of laboratory and field data resulting from experiments undertaken to determine this point, however, seem to indicate that the *amount* of oil adhering to the fruit throughout the growing season is a factor of greater importance. From these studies the necessity of using oils for summer spraying of not more than 65° (Saybolt) viscosity is emphasized.

Experiments are in progress to test the feasibility of adding unemulsified mineral oil to the mixture of water, bordeaux, spreader, or other spray ingredients of the spray tank and to depend upon agitation by rapidly moving paddles to obtain uniform dispersion of the oil globules.

Bordeaux mixtures. In cooperation with the United States Department of Agriculture a study of the relative adhesive properties of commercial and home-prepared bordeaux mixtures is being continued. Excepting the dusting bordeauxs, all commercial brands of bordeaux powder used experimentally for the last two years for the control of anthracnose compare very favorably in results obtained with home-prepared bordeaux. Commercial brands have undergone a substantial improvement in adhesive qualities in the last few years. Experiments to determine what combinations of bordeaux mixtures cause spray injury to walnut leaves thus far are inconclusive.

Toxicity of lead arsenates. Some entomologists claim from results obtained in the control of the codling-moth that there are differences in toxicity between the various commercial brands of lead arsenate. At present all the commercial brands used in the Pacific Northwest are the acid lead arsenate type. Numerous analyses have shown that relatively small differences only prevail in the actual arsenic pentoxide content of these commercial brands. Furthermore, studies of the commercial brands show that comparatively small amounts of the neutral or basic forms are present. From these studies it would seem that actual differences in toxicity must be due to some other factor than composition. Deflocculators might not be wholly innocent of protective action.

To check the accuracy of the entomological observation noted, toxicity tests on caterpillars under control conditions are being made with various brands of commercial lead arsenates. The caterpillars are allowed to eat of the poison until death occurs. Chemical analysis of the dead bodies and of the excrement should give data by which to judge the relative toxicity of the arsenates used.

Spray residues. The user of arsenicals for the control of insect pests is under the necessity now of removing from his product before it is marketed the excess of spray residue adhering to it above the maximum allowed on food products by state and federal pure food regulations. Remarkable success has been attained in this state in gaining control of this situation, particularly as it affects apples and pears.

During the past two years strenuous efforts have been made to improve the acid washing of apples and pears so as to make this 100 percent efficient. The residues of oil emulsion sprays, deflocculants, and the natural wax of apples and pears prevent to the extent of some 6 to 8 percent of the crop the perfect cleaning of these fruits by the acid wash alone. Various combinations of inorganic salts with hydrochloric acid have been tried recently to obtain a greater solvent effect in these difficult cases. Some improvement in the cleaning effect was noted, but greater promise at present seems to lie in certain combinations of organic solvents for oils and waxes with the hydrochloric acid in the washing solution. So promising do these combinations appear that application has been made for a public service patent covering their use.

The growing practice of spraying string beans with arsenicals for the control of beetle and weevil infestations made necessary also an investigation to ascertain whether the spray residue on this crop at harvest time exceeded the tolerance of arsenic allowed by pure food regulations. No samples thus far examined, fresh or canned, very closely approached that tolerance. This same investigation has shown, however, that in case of need fresh string beans, with a .05 percent solution of hydrochloric acid, can be cleaned far below the tolerance allowed for arsenic with no bad effects on the product. In the natural course of events attention in the near future will have to be given to spray residue on other vegetable and fruit crops. Even now gooseberries and sweet cherries are demanding some attention from that point of view.

Spray residues require and have been given attention also from another angle. Arsenic, lead, and copper occur naturally in plant substance in extremely small amounts. Will the long-continued addition of these elements to the soil in the form of spray residues eventually affect unfavorably the nutrition of plant life, or become an ingredient of the edible portions to such an extent as to require reckoning with in human and animal nutrition from the standpoint of toxicity? Thus far we can reply in the negative only for apples and pears.

ANIMAL NUTRITION

In this field the program of investigation for some time has involved chiefly the study of the nutritive properties of alfalfa when rations are restricted solely or largely to the alfalfa plant. The problems presented are of considerable practical interest in view of the fact that large numbers

of farm animals in certain sections of the West are restricted in rations largely to alfalfa. The work is carried on with both laboratory animals and dairy cattle, the latter phase in cooperation with the department of Dairy Husbandry.

Metabolism experiments with dairy cattle. Dairy cows have been fed on rations consisting of alfalfa hay and of alfalfa hay plus a supplement of di-sodium phosphate, bone flour, or calcium carbonate. The outstanding result of these studies is that cows in the early lactation period, when restricted to alfalfa hay, have without exception been found to be in negative phosphorus equilibrium. Supplements of di-sodium phosphate or bone flour have resulted in positive balances. It would appear, therefore, to be good practice to supplement an alfalfa ration with feeds rich in phosphorus.

The nutritive value of alfalfa proteins. The extensive use of alfalfa makes it desirable also to obtain more specific information than we now possess on the nutritive value of alfalfa proteins. With rats as the experimental animals, a series of studies recently completed shows very clearly that the biological value of alfalfa proteins is limited by the sulfur-containing amino acid cystine. This kind of information, of course, ultimately will assist in the proper choice of feed as supplements for rations consisting largely of alfalfa.

HORTICULTURAL BY-PRODUCTS AND FRUIT STORAGE

This work is done in cooperation with the department of Horticulture. It is concerned with the chemical phases of problems that are pressing for immediate solution in the preparation of orchard and garden crops for market and involves a thorough investigation of the chemical and physical properties of these food products.

The prune crop. There is apparently no standard in the matter of maturity of the prune crop, a part of which is marketed as fresh fruit. Chemical tests covering the harvesting period of two years quite clearly show that substantial improvement in quality, as judged by sugar and acid development, is possible by a brief period of common storage intermediate between picking and marketing.

The larger part of the prune crop reaches the consumer in dried form. Extensive tests of the crops of four or five years indicate clearly that substantial improvement in the grading process insures uniformity in quality. This is realized through the employment of the flotation principle and the use of sugar or salt solution to separate the fresh fruit into heavy- and light-weight fractions whose chemical and physical characteristics—sugar, acid, color, and texture of flesh—carry over almost perfectly to the dried product. As a result dried prunes scientifically graded for uniformity in quality ought soon to prevail in dried prune markets.

Pears. Extensive chemical examination of two varieties of pears is in progress to obtain a better understanding of the cause of core breakdown and scald which result upon removal of fruit after too long a period in cold storage. Thus far none of the chemical changes noted in ripening processes correlates with this particular trouble.

Cherries. Royal Ann cherries are quite prominently in demand for Maraschino purposes. Several good combinations of chemicals have been found for bleaching the cherries to the desired color with maintenance of a firm flesh free from checks.

Strawberries. The objective with this fruit at present is the determination of the role played by maturity (as judged by development of sugar and acid) in the quality of fresh strawberries preserved by freezing.

PLANT AND SOIL

In a large measure the work of the biennium with plants and soils is in cooperation with the Southern Oregon Branch Experiment Station.

Little leaf. This manifestation of some sort of distress in apple and pear orchards, while not particularly alarming, is serious. It is to be found all over the Northwest in fruit-growing sections. For several years attempts have been made in Southern Oregon to correlate it with some soil characteristic. Careful examination of field and laboratory data, however, gives only a hint that there may be the relationship of cause and effect in the presence of strata of free limestone in the soils of orchards which also show some "little leaf."

Pear soils. The pear soils of Southern Oregon are of many series and types. The close-textured soils—adobes and clays—seem to be given the preference by growers of some varieties. Chemical examination of soils and fruit has shown an interesting—possibly an important—relationship in the matter of calcium content. The heavy soils, in contrast with the light or sandy ones, are rich in exchangeable calcium. Bosc pears from orchards on the heavy types of soils, in contrast with those from orchards on light or open-textured soils, are also rich in calcium. It may be that the greater abundance of calcium available to the fruit growing on heavy soils is advantageously used by it in making heavier and more resistant cell walls, for they consist largely of calcium pectate.

OTHER DEPARTMENTAL ACTIVITIES

State reguatory service. Responsibility rests upon the Chemistry department for the enforcement of three state laws, viz.: fertilizer control, agricultural lime and gypsum, and economic poisons. Possibly these laws have been more cheaply enforced by this arrangement than would have been the case by any other. The department, however, because of insufficient income for the purpose, can keep a man in the field for inspection work for a fraction only of the time that thoroughly effective enforcement of each law requires.

The economic poison law is a modern law. The other two are out of date. The steady expansion of the fertilizer trade and the increase in the use of agricultural lime require revision and modernization of the laws under which fertilizers and agricultural lime are sold. The objective of each of these laws, of course, is to protect purchasers against fraudulent practices and insure the quality of goods. Fertilizers, agricultural lime and economic poisons are required to be sold under the manufacturer's or deal-

er's guarantee in the matter of composition and quality. Analytical work required by law is largely for the purpose of checking on these guarantees.

For the biennium there have been collected and analyzed a total of 201 fertilizers, 61 agricultural limes, and 273 economic poisons. Relatively few attempts at law evasion or of fraudulent practice have been detected.

Miscellaneous. Many miscellaneous analyses have been made of materials sent to the department by county agricultural agents, private firms and individuals seeking specific information. During the biennium 350 such analyses were made, including the analysis of pears, apples, mineral feeds and bones, pasture grasses, irrigation water, soils, stomach contents of supposedly poisoned animals, blood and flesh, swollen canned goods, and otherwise damaged fruits and vegetables.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MARKETING

Incidence of taxation for public schools on rural and urban property. Work on this project was started in October, 1929, and will probably be completed by July 1, 1931. The project is not sufficiently advanced to reveal results. The work consists of a statistical study based upon information culled from assessment and tax rolls of the different counties in Oregon. The object is to measure the relative importance of the public expenditures by the state and local government for the various utilities and services publicly maintained and to indicate the trend in these expenditures for the years 1910 to date.

The market situation and outlook for berries in Oregon. The purpose of this project is to study the price cycles and the trend for Oregon berries in order to assist growers in making profitable adjustments in their production programs.

Berry production in Oregon has increased considerably in recent years and the change in price trends has been an important influence in determining trends in acreage.

DEPARTMENT OF AGRICULTURAL ENGINEERING

Cream refrigeration on the farm. The purpose of this project was to determine the effect of refrigeration of cream on the different quality factors, particularly as they relate to butter or other products manufactured from the cream, also to study cost of equipment necessary to maintain suitable refrigeration. In the preliminary work which has been completed it was found that refrigerated cream could be held 4 days on the farm and still grade as No. 1 cream. Further work is necessary to determine the quality of manufactured products from cream thus held on the farm and the work is being continued.

Milk cooling and refrigeration. This study consisted of testing the rate of cooling and bacterial growth of milk cooled by electric refrigeration in a tank-type refrigerator and determining the cost of equipment and oper-

ation. Specifications of homemade tank-type refrigerators were developed. The results of this study are given in Bulletin 268, which is summarized elsewhere in this report.

Electric brooding. The purpose of this project was to study the cost of operation and the general performance of electric brooders as they affect mortality, weight, rate of growth and feed requirements of baby chicks. Many poultrymen have questioned the advisability of the use of electric brooders during freezing weather without supplemental room heat. The tests were made, however, during a period of cold weather in January and February when the temperature dropped to zero. The brooders operated satisfactorily without supplemental room heat. The mortality and general performance were satisfactory. The results of this investigation are presented in Bulletin 262.

Electric sterilizers. This project was designed to determine the effectiveness of sterilization with water vapor at temperatures ranging from 140° F. to 200° F. together with the cost of operation and installation of such sterilizers. The value of insulating walls of sterilizers to reduce power consumption was also given consideration. The tests were completed on four different makes of electric sterilizers and indicated that 175° F. is the minimum sterilizing temperature. Additional tests are being made and the work will be continued into the next biennium.

Water heating. The object of this project was to study cost of heating water for dairy work rooms with (a) electricity, (b) various types of heaters and (c) thermostats and different types of tank insulation. The hot-water requirements for washing dairy utensils and the most desirable temperatures to maintain in hot-water tanks were given special consideration. This work will be continued during the next biennium.

Hay chopping. This project was designed to determine the rate of chopping hay with electric motors of 5 to 10 h.p., also to determine the power consumption per ton of hay chopped. It was found that the power required to chop hay and blow it into the barn was 3 to 4¼ kilowatt-hours per ton and that 1 to 1½ tons per hour could be chopped with the 5 h.p. motor.

Silo filling. Tests were conducted to determine the rate of filling silos when electric motors of 5 to 7½ h.p. were used as the power unit. It was found that the power required to chop and blow silage into the silo was 1.3 kilowatt-hours per ton.

Feed grinding. The purpose of this project was to study the efficiency, power demand, rate of grinding, fineness of grinding, and general operating characteristics of feed grinders for 3 to 5 h.p. electric motors. The results indicate that the small hammer mill has been developed to the point that it has many advantages over the small burr mill. Work on this project is being continued to study later types of feed grinders.

General farm refrigeration. Efficiency tests were made of the cost of operation and the influence on temperature of circulation in a special farm refrigerator box of 40 cubic feet capacity made in the laboratory. A second

box has been built to serve general farm purposes so arranged that 12 cubic feet can be used for the general household while a tank-type unit capable of holding 4 five-gallon cans of cream or milk may be utilized for dairy refrigeration. Work on this project will be continued.

DEPARTMENT OF ANIMAL HUSBANDRY

Following is a brief statement of work and results by projects.

Chevon. Chevon (goat meat) has been carefully studied from the standpoint of palatability and quality by methods outlined by the American Committee on Quality and Palatability of Meat. These tests showed that chevon was equal in quality and palatability to lamb or mutton of similar age and condition, the judges being unable to distinguish chevon from mutton. The Angora goats, however, mature slowly and do not fatten readily so that it would be difficult to obtain young goats carrying the same condition that is found in the choice grades of lambs.

Economic survey of the Angora goat industry. The study of 86 goat ranches during a period of three years shows an average cost of producing mohair of 73½¢ per pound, with the bulk of ranches showing costs ranging from 30¢ to 90¢. These figures included interest on all the investment at prices fixed by the owners. Allowance was not made, however, for the benefits which usually are derived from the clearing of brush through the use of goats. This survey also showed that goats in Oregon are kept almost exclusively for mohair production. Very few are sold for meat or for any other purpose.

Clearing brush with goats. In an experiment in goat grazing it was found that all the more common deciduous shrubs, young trees, and young conifers characteristic of Western Oregon are eaten by goats and may be killed by persistent browsing. Poison oak was eaten but only when feed was short. The only common Western Oregon shrub which has so far shown itself fully resistant to goat browsing is the common Scotch broom.

Irrigated pastures. Five years of work with irrigated pastures for farm sheep have been completed. By better management and better irrigation the yields of these pastures have been constantly increasing until in 1929 the yield was 2297.6 sheep days per acre. All during the summer season these pastures carried 15 sheep per acre. This was on good land, well fertilized. This heavy stocking, however, has resulted in severe infestation with stomach worm.

Rape for summer pasture. Rape for summer pasture on land of medium quality has given yields of 253 sheep days per acre where the rape was sown in rows and 270 sheep days where sown with clover. Rape in some form has so far been practically the only really satisfactory feed for pure-bred lambs during July, August, and September, but the yield has been disappointingly low and the expense high. Rape pasture for pigs has materially increased the rate of gain and one acre of rape has saved from 700 to 800 pounds of grain.

Spring lamb production in Western Oregon. The results of spring lamb studies indicate that a farm price of 10¢ a pound for lambs and 35¢ a

pound for wool is required to justify sheep production with current prices of rent and feed. The results of these studies are published in Circular 94.

Marketing lambs. A thorough study has been made of the problem of marketing lambs from Western Oregon and the results published in Bulletin 265. This study indicates that while the percentage of top lambs from Western Oregon is now 33 percent, this can be raised to 80 percent. This means that the value of 47 percent of the lambs could be increased approximately $2.00 a head, which would add approximately $140,000 to the annual income in Western Oregon.

Capacity and durability of hammer type feed grinder. A Rowell No. 1 hammer mill was used in grinding approximately 150 tons of barley, oats, and corn. The oats and barley were mostly finely ground, the corn coarsely ground. The repairs required on the mill during the test were the rebabbitting of a bearing on the agitator and replacing a small piece of sheet iron in the housing of the mill. The main part of the mill and hammers were in good condition at the end of the test. The kilowatt-hour per bushel and the capacity of the mill were determined for different fineness of grinding. The coarse grinding of barley required slightly more power than coarse grinding of oats. Fine grinding of oats required slightly more power, however, than fine grinding of barley. The grinding of corn required less power than for either oats or barley.

Preparation of grain. Six experiments have been conducted over the past five years as follows: oats and barley have been fed as whole dry grain, whole soaked grain, coarsely ground, finely ground and steam rolled, supplemented with tankage, alfalfa meal, and minerals. The fine grinding of oats and barley proved to be the best preparation for these grains, as pigs receiving this ration made greater daily gains and required less feed per 100 pounds gain. The steam-rolled barley compared very favorably with finely ground barley from the standpoint of feed per pound of gain as the requirements were practically the same, but the cost of steam rolling barley is considerably higher due to the labor required. The steam rolling of oats was not as satisfactory as coarse or fine grinding, as it increased the amount of feed required per pound of gain and decreased the daily gains. The power and labor cost of steam rolling barley was $2.25 per ton while for fine grinding it only required $1.01 per ton. Most of the rations fed were oats until the pigs weighed 100 pounds, when they were changed to a fattening ration of barley. In each of the experiments one lot was fed either coarse or finely ground barley the entire time. The lots receiving coarse or finely ground barley throughout the entire test made more rapid and economical gains. This will probably indicate that barley is as good a grain for growing pigs as oats.

Manioc meal. Feeding experiments were conducted with manioc meal, which is a tapioca flour made as a by-product in the manufacturing of tapioca. Manioc meal analyzes approximately 77 percent carbohydrate, about 1 percent fiber, and has a very small amount of protein and minerals. Manioc meal was fed in two different experiments in different proportions ranging from one-third to two-thirds of the ration, supplemented with tankage and alfalfa meal, and in one experiment molasses was added to the ration. In both experiments in which the pigs were fed manioc meal one or two pigs made practically no gains and in one experiment one pig died.

The value of manioc meal, as figured from the results of these experiments, is about three-fourths the feeding value of ground barley when the meal composes about one-third to one-half of the ration. It does not seem advisable to feed manioc meal as more than one-third of the grain ration for growing and fattening pigs.

Value of rape pasture in growing and fattening pigs. Rape pasture increases the daily gain and reduces the amount of grain required to produce 100 pounds of gain by amounts varying from 40 to 70 pounds. An acre of rape pasture will carry from 15 to 20 pigs when the pigs are fed a full grain ration. An acre of rape pasture will replace an average of 727 pounds of grain for fattening pigs.

Effect of water in a pig's ration. Two experiments were conducted in studying this problem. Water was added to the grain mixture in different proportions at the time of feeding. The amount of water in a pig's ration up to four pounds of water to one pound of grain does not materially influence the daily gain or the economy of gains. In the utilization of low-grade wastes the amount of crude fiber seems to have a greater influence than the water content.

DEPARTMENT OF BACTERIOLOGY

Microbiological study of certain Oregon soils having an acid reaction. The increased acreage of alfalfa in Western Oregon has developed problems in connection with inoculation and maintenance of this crop. Field tests indicate that inoculation generally means the difference between success and failure on soils that are well prepared, so that the practice of inoculating alfalfa is generally adopted. During the biennium the major work on the project was concerned with the question of nitrogen-fixation by bacteria, including both root-nodule bacteria and non-symbiotic nitrogen-fixing bacteria.

The non-symbiotic nitrogen-fixing powers of Willamette Valley seem to be low. In many samples of soil it was difficult to find the presence of the Azotobacter group. These studies are being continued.

Infectious mastitis in cattle. During the biennium a bacteriological study has been made of mastitis, the object being to determine the difference in the udder flora of infected cows and non-infected cows. Aseptically drawn milk was studied, samples being taken at intervals of two weeks and the dominating organisms in each case were studied in detail and classified. These studies will be continued during the next biennium.

Survey of market milk. Cooperating with the State Dairy and Food Commission a study was made of the market milk in all Oregon towns having a population of 1,000 or more inhabitants. The results which show the quality of the milk from a sanitary standpoint and also the butter-fat content will be published in bulletin form.

Cultures for legume inoculation. There is a growing demand for artificial inoculation material for leguminous crops, 5,500 legume cultures being prepared and distributed in the first year of the biennium and 7,100 during the second year. These cultures are all tested and every precaution

is taken to keep them pure and vigorous. Reports indicate that these legumes are very beneficial in obtaining good stands of legume crops, especially alfalfa in the Willamette Valley.

Vaccines for hemorrhagic septicemia. The department has continued to prepare vaccines for this disease and send it to farmers requesting the vaccine. Although funds of the Station have been too limited to make definite investigations relative to the efficiency of this treatment for the disease, farmers using the vaccine report favorably and in cases where there has been a definite outbreak the disease has been apparently controlled. There is need for additional experimental work on this disease.

Sanitary tests of market milk. The department made approximately 8,600 bacterial analyses of milk during the biennium. Requests for this type of work are increasing, and these tests have had far-reaching effect in improving milk quality in communities where the milk has thus been tested.

Clinical diagnoses. Clinical diagnoses of all kinds are being made by the department at the request of practicing physicians, hospitals, and individuals. Approximately 500 such tests were made during the biennium. No attempt is made to expand this work, which is definitely of a public health nature, but a definite service is rendered by members of the department staff.

Sanitary tests of water. Approximately 2,000 tests of water were made during the biennium. These tests include water from swimming pools, rivers for recreational purposes, wells and springs for farmers, and city and town water supplies. Besides making the tests, attempt is made to remedy conditions where the water shows contamination. This service is resulting in marked improvement in the water supplies throughout the state, and people are generally much more aware of the importance of pure water, but there is still much to be done.

Accuracy and reliability of the standard plate method for bacterial analyses of milk. The large number of analyses of milk made by the department presents an unusual opportunity for testing the efficiency of the standard plate method for bacterial analyses. In these tests it has been possible to eliminate most of the sources of error responsible for criticism of this method, and the results prove conclusively the accuracy of this method of testing milk quality.

Further work is needed to test the efficiency of the standard plate method in determining type of pollination in milk. Additional studies will be made of pin-point colonies.

Other work. The department has cooperated with other Station departments on projects requiring bacterial analyses, including (a) Mechanical refrigeration of milk in a Tank-Type Refrigerator, (b) Artificial refrigeration, (c) Sterilization by electricity, and (d) Sanitary survey of the Willamette River.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY

Diseases of bulbs. (Cooperative with the Office of Horticultural Crops and Diseases, United States Department of Agriculture.) In the experiments with narcissus mosaic, repeated attempts to transmit the virus by one means or another failed, until in 1929 very successful results were obtained by the use of a simple leaf-mutilation method. This method is being used to analyze further the nature and behavior of the disease. The means of spread in nature, however, is still unknown.

Extensive experiments with tulip mosaic in which controlled inoculations were employed, demonstrated that tulips of all the primary color types are susceptible to this disease which has been known for centuries as "breaking." The 1929 tests showed that this "breaking" of the tulip is not a simple matter of color-rearrangement as had been assumed previously but that this phenomenon follows some definite law which may be of real import in certain types of plant breeding.

Roguing tests with iris mosaic conducted over a period of years have given indifferent results, which is an indication that more information is needed as to the natural means of spread of the disease. The tests of last year showed that iris mosaic is more readily transmissible than any other disease with which the bulb project has been concerned. Several species of aphids are able to carry the disease. Almost any type of mechanical means of inoculation may be successful.

For the control of tulip fire, an extensive series of tests was conducted in 1928 and 1929 using many different chemicals for attempted disinfection. In general only negative results were obtained.

Verticillium wilt of black cap raspberry. The rotation tests started during the previous biennium to determine how long other non-susceptible crops must be grown on diseased ground before the soil is free from the wilt organism, have been continued. Verticillium from both black cap and from potato have been employed to infest the ground. The behavior of the disease is being studied on 25 varieties of bramble fruits. The three varieties grown commercially in Oregon—Munger, Plum, Farmer and Cumberland—are all susceptible to the disease. No black raspberry variety which has been tested to date appears to be resistant. All inoculated plants, whether showing distinct symptoms or not, are dwarfed by the disease and mature little desirable fruit. Some instances of total recovery of affected plants seem to have been met with in the test blocks.

During the first, second, or third year after inoculation, however, 30 to 40 percent of the plants show dying of some or all canes. Uninoculated control plants set 9 feet from inoculated plants have not shown the presence of wilt until the third year when 2 percent showed its effects. A publication on the behavior of the wilt is contemplated for the near future.

Virus diseases of potatoes. This project, which was conducted with the cooperation of the Office of Horticultural Crops and Diseases, United States Department of Agriculture, was closed April 1, 1930, when the leader withdrew from the Experiment Station. The results of the work for the past few years are being prepared for publication.

In brief the work has demonstrated that tuber-unit roguing of potatoes is more effective than so-called mass roguing in the control of virus diseases.

Experiments to determine what insects are capable of transmitting the various virus troubles have shown that three species of aphids, not common in potato fields, *Myzus persicae, M. pelargoni* and *M. circumflexus,* are able to transmit leaf roll readily, while the commonest aphid of our potato field, *Illinoia solanifilii* transmits this disease but rarely. Attempts to transmit other virus diseases by these aphids have thus far proved ineffective.

Crinkle mosaic and spindle tuber may, under unfavorable conditions for growth, reduce the yield from 40 to 60 percent.

In a study of other possible host plants of the potato virus diseases it was found that by means of an aphid, *Myzus persicae,* the leaf-roll disease may be transmitted from potato to tomato, pepper, black nightshade, Jimson weed, bittersweet (*Solanum dulcamara*) and *Datura tatula.* This emphasizes the danger to potato fields of the presence of weed carriers of virus diseases in the vicinity. Artificial inoculation methods resulted in successful transfer of rugose mosaic from potato to tomato and black nightshade.

Further studies along the same line will be continued in Oregon under the United States Department of Agriculture by Mr. T. P. Dykstra in cooperation with the Station at Corvallis.

Fresh fruit disinfection. During the biennium the investigations on fruit disinfection to reduce shipping losses, were continued. Most of the materials tried, including acetic acid, borax, and boric acid solutions and formaldehyde solutions have proved ineffective or objectionable. The degree of control was in no case sufficient for commercial purposes due to the very large amount of incipient infection with rot existing in the fruit at the time of treatment.

In 1929 sweet cherries of the Bing and Lambert varieties were given a number of treatments previous to a storage period. Hexylresorcinol (S. T. 37) in full strength as sold by druggists failed to give any satisfactory evidence of control. Acetic acid solutions again proved valueless for brown rot and blue mold decay. Formaldehyde used as a dip produced fair control of rot when employed at a concentration of 1 part of commercial solution to 75 parts of water. Better protection, however, appeared to result from the use of absorbent paper soaked with formaldehyde solution in different concentrations placed in the bottom and also in the tops of the boxes of fruit at the time of packing.

Too great concentrations with the liquid dip or with the use of impregnated paper injured the flavor and color of the cherries but with the weaker concentrations employed no effect on flavor, odor, or color could be noted with the dark cherries, although marked reduction of decay was accomplished. More recent tests with light-colored cherries, however, indicate that these are subject to noticeable skin discoloration at concentrations that gave no indications of deleterious effect with the dark cherries.

A powder composed of diatomaceous earth impregnated with formaldehyde and dusted over the fruit gave excellent protection against decay with no indications of injury except for a slight loss of glossiness, but the presence of the powder on the fruit surface is in itself an objection. The work is being continued to determine whether such methods can be made commercially practicable.

Strawberry root-rot. Four distinct root troubles have been observed in strawberry plantings during the biennium. In 1928, isolation cultures were made from more than 2,700 affected plants. Inoculation work and field studies have also been carried on during the two years. The results point to the following as the chief causes for root injury to Oregon strawberries:

1. Armillaria root rot.
2. High water-table and adverse soil conditions.
3. Winter injury.
4. Rhizoctonia attack which is mostly confined to the sandy-loam hill lands, especially to virgin soils.

1. *Armillaria mellea* as a cause of root rot of strawberry has been observed in four different places during the two years: i.e., Washington, Marion, Yamhill, and Linn counties. Previously field examinations had been made or specimens identified from Astoria, Newberg, Lacomb, and North Albany.

This Armillaria root rot of strawberry is always found on newly cleared land or where orchards or shrubby plants have been grown. As a rule in each case a few scattered plants were affected. The plants first yellow, stunt, wilt, and die. In advanced cases, the crowns are filled with felty fungous growth.

2. *The difficulty with high water-table* mostly affects the Ettersburg 121 which is grown on flat land. The Marshall variety is affected worse, however, when in poor locations. In these plants there is a lack of fibrous roots and the crowns are discolored (reddish) internally.

3. *Winter injury* is worse under the conditions mentioned in 2, but if the soil is frozen the heaving effect breaks the root system and a wilting effect is produced.

4. *Rhizoctonia* sp. has been isolated from the small dark cankers on the roots and from the outer layers of the crowns of strawberry plants in eight Oregon districts.

There seems little question as to the cause of the disease, but control measures are difficult to formulate. Rotation of crops has been started on land which is thoroughly infected with the disease.

Bacterial blight of filbert. This disease is a serious cause of losses in young plantings, as large numbers of trees may perish in a single season. In order to permit satisfactory study of various phases of the disease, plantings have been made at Corvallis which include several varieties of filberts. Isolations from affected trees from widely scattered groves indicate that there is but a single type of organism associated with typical cases of the disease, which resembles exceedingly closely the organism responsible for the bacterial blight of the walnut (*Bacterium juglandis*). Certain differences, however, have been noted in the behavior of strains isolated from the filbert and walnut, which are being studied further. The project will be continued.

"Curly top" disease of vegetables. With the cooperation of the Office of Horticultural Crops and Diseases, United States Department of Agri-

culture, extensive tests on "curly top" have been conducted at the Umatilla Experiment Farm, Hermiston. The primary object of this work has been to test as many different varieties and varietal selections as possible of truck crops to determine their relative susceptibility to "curly top" attack and to pick out such as show any promise of resistance in the hope that from these selections valuable sorts might eventually be developed to replace those which readily succumb to the disease.

In 1928, the tests included 201 varieties of 26 crops, from which 57 seed selections were made for 1929 retesting. In 1929 some 418 varieties or selected strains of 20 crops were included in the work.

Certain strains among non-resistant crops, although highly susceptible, produce heavily in spite of infection. Certain varieties succumb so slowly to infection by the "curly top" virus that they come nearer to producing a crop than others which succumb rapidly. Certain strains of vegetables which have been popularly considered as "blight proof" or resistant to "curly top" have proved to be highly susceptible when actually put to the test by natural or artificial infection.

Miscellaneous diseases. Brief and incomplete studies have been made of the following fruit diseases during the biennium:

1. Strawberry leaf spots, two fungous diseases known as leaf scorch and leaf blight.
2. The basal canker of red raspberry.
3. "Witches broom" disease.
4. A serious leaf spot disease of yellow Newtown Apples in the Rogue River Valley.
5. Rose cankers.

Walnut blight control experiments. In cooperation with the office of Horticultural crops and diseases, the Experiment Station has checked the results of sprays applied by growers for the prevention of Walnut blight. The results thus far indicate the effectiveness of properly timed spraying with bordeaux but show that there is danger of injury. This project has now been taken over by Dr. P. W. Miller, who, as representative of the Office of Horticultural Crops and Diseases, will continue the work in cooperation with the Oregon Station.

Cherry bud blight. There has been isolated repeatedly from buds that died during the winter, a fungus which has produced a rot of apple through artificial inoculation which cannot be distinguished from the type of decay produced in apples by the perennial canker and anthracnose fungi. This type of fungus has not, however, been isolated with sufficient regularity to permit the conclusion that it is the chief agent involved in the dying of the cherry buds during the dormant season. There are evidences that physiological conditions may be responsible for much of the blighting. Whether these have to do with water relations or nutritional factors remains for further study to determine.

European brown rot blossom blight of stone fruits. Studies in 1929 and 1930, when severe blossom blight of cherries was experienced in Western

Oregon, showed that the European brown rot (*Sclerotinia cinerea* forma *pruni*) is the chief offender, although occasional blight of blossoms is caused by the common fruit-rotting American brown rot (*Sclerotinia fructicola* also known as *Sc. americana*). The chief protection against the European form is afforded by a thorough pre-blossom spray with bordeaux mixture applied just as the petals show white.

Coryneum blight of stone fruits. This disease is ordinarily confined in its severe attacks to the peach and is known as peach blight; but serious damage to cherries from a fruit spotting organism was found in Union county in 1929. Cultural studies showed this to be produced by the blight fungus, *Coryneum beijerinckii*. In 1930 serious damage was reported on cherries on one tree in a Willamette Valley town, and cultures proved this to be caused by the same fungus which had spread by spores from an adjoining badly diseased peach tree. From the northern Willamette Valley have been received specimens of serious leaf-spotting and shot-holing on prune due to the same fungus. It is clear that this disease is more important than has hitherto been considered.

Northwestern foot-rot disease of wheat. This work is directed solely by the Office of Cereal Crops and Diseases. The field, laboratory, and greenhouse work on this problem aims at completing as soon as possible our knowledge of the life of the causal organism. Control studies are being continued and a beginning of the study of environmental factors influencing the disease has been made. The chief organism isolated from diseased plants has been shown to be pathogenic and to have a conidial stage similar to *Cercosporella herpotrichoides*. Fron. Emphasis in field work continues to be placed on a search for resistant varieties.

DEPARTMENT OF DAIRY HUSBANDRY

The work in animal nutrition studies and diseases of dairy cattle was continued in cooperation with the Nutrition Chemist and with the department of Veterinary Medicine. The following projects were undertaken:

A study of the metabolism of dairy cows on rations consisting principally or solely of alfalfa hay. In this project four animals are available which have been receiving rations of alfalfa hay and a grain mixture consisting of 2 parts barley and 1 part oats. It is thought that a mineral balance on these animals will give some idea as to the supplementary value of these two home-grown feeds. It would seem from results now available that an additional supply of phosphorus would be warranted in the ration of cattle receiving alfalfa hay as their source of nutrients.

Work done by Dr. Haag with young animals would indicate also that the quality of the alfalfa proteins is not of the best, and that the addition of small amounts of cystine makes an otherwise poor quality of alfalfa protein entirely adequate for small animal growth. It is known that cystine is essential for milk production, so it is possible that a combination of cystine and phosphorus are concerned in the low production of animals receiving a ration consisting of alfalfa hay alone.

Pasture investigations. Owing to the urgent need for improved pastures in the Willamette Valley major emphasis was given to this problem during the biennium. The returns from a tract of 11¼ acres of irrigated Ladino clover pasture were equivalent to about 30 percent interest on the $150 per acre investment. During the 1929 season the 11¼ acres of irrigated pasture were utilized for a total of 7,032 cow days, which is equivalent to pasturing 3.74 cows per acre for the pasture season of six months. The pasture return was equivalent to about $46 per acre for the season, as determined by the saving in feed over what the cows would have been fed were they kept in the barn. The average cow consumed feed from the pasture equivalent to 10 pounds of alfalfa hay and 19⅓ pounds of corn silage per day.

Data are now being accumulated for the 1930 pasture season on this same tract of 11¼ acres of irrigated Ladino clover pasture, and results to date indicate that even better returns will be obtained than during the 1929 season.

Other tests are being made on two additional tracts of land.

Kale versus corn silage for milk production. The purpose of this project was to compare the feeding value of kale and corn silage to determine the most economical amounts to feed and to ascertain the effect of kale on the quality of products produced. Work was started in the fall of 1925 and closed in the spring of 1929, and a bulletin reporting results is now being prepared.

Four feeding trials, one each year during the study, were conducted. It was found that on the average 1 pound of corn silage was equal in feeding value to 1⅓ pounds of kale. When kale replaced one-half of the corn silage in the rations, no decline in production resulted. When the cost of growing, yield, and feeding value of kale and corn silage are considered, it was found that one acre of kale nets greater returns than does two acres of corn silage. Kale should be fed after milking to prevent objectionable feed flavors in milk and butter.

During the fall and winter of 1929-30 a feeding trial was conducted to determine the most economical amount of succulence to feed. Corn silage was used as the succulence and the cows were fed a light amount of dry matter but varying amounts of silage, ranging from 10 pounds per day to as high as 50 pounds per day. The results of this trial have not yet been completely summarized.

Practical studies with alfalfa hay. The purpose of these studies was:

1. To determine the value of chopping alfalfa.
2. To compare the feeding value of Eastern Oregon and Willamette Valley alfalfa.
3. To determine the economy of feeding grain with alfalfa hay and the most economical supplement to feed.

The data are not yet conclusive and further work is being done. The results to date indicate:

1. No great superiority of Eastern Oregon alfalfa over that grown in the Willamette Valley.

2. A value in chopping hay, but the economy of the practice is dependent upon the cost of chopping.
3. Uneconomical production on alfalfa hay alone.
4. Economy in feeding succulence and grain mixtures high in phosphorus with alfalfa hay.
5. Animals receiving two parts barley and one part oats in addition to alfalfa hay are doing consistently better than those receiving nothing but alfalfa hay.

Mineral requirements of growing heifers. This project, started in 1925, was to determine the effect on dairy heifers of rations of various mineral content on the growth, reproduction, and the production of milk and butter-fat.

Twenty-one heifers of four breeds used in experiments were placed on definite rations and accurate feed records kept from birth. The results were measured by growth, reproducing ability for two generations, and milk and butter-fat production for one lactation.

The results to date are not conclusive. They indicate, however, that there is a relation between the reproducing ability of animals and the ration they receive, inasmuch as animals which have received rations low in minerals have shown considerably more breeding difficulty than have animals receiving rations higher in minerals and vitamins. There is an indication of a direct relation between the mineral content of the ration and milk and butter-fat production.

Sterility and difficult breeding in dairy cattle. The Station is making a definite attempt to solve the problem of sterility and difficult breeding in dairy cattle, studying the problem from the following aspects :

1. Care and management of the bull.
2. Vitality of spermatozoa.
3. Infectious disease in the cows.
4. Condition of the genital organs of cows at time of breeding.
5. Feeding a vitamin supplement in persistent cases.

A total of 99 cows and heifers of breeding age have been studied since this work began and the study will be continued, inasmuch as the problem is one of real economic importance and is difficult of solution.

Abortion investigations. Studies in the problem of contagious abortion have continued through the biennium in cooperation with the department of Veterinary Medicine. A study of some of the economic losses due to abortion infection in dairy cattle reveal the following points:

1. The useful life of a cow infected with abortion is probably shortened by at least 20 percent.
2. Nearly 30 percent of cows that aborted failed to drop normal calves again.
3. In a badly infected herd the calf crop is reduced by approximately 35 percent.

4. The most serious decline in milk production comes in the lactation immediately following an abortion. This decline averages about 30 percent.

5. A decline of 20 percent of the expected production is observed in normal gestations of infected cows.

6. When the decreased milk yield and loss of the productive life are both considered, a heifer that aborts her first calf may be expected to produce only about 55 to 60 percent of the yield that would be expected had she not become infected.

Proved sire project. (In cooperation with the United States Dairy Bureau). This project, started in 1925, is designed to determine whether a proved bull which has transmitted uniformly high milk and butter-fat production capacity on certain blood lines within a breed of cattle will continue to transmit this quality of production when used on other blood lines in the same breed.

The United States Dairy Bureau furnished the sires used in this project. Colantha Pontiac Hero, No. 277647, sired seven daughters in the college herd. One daughter, failing to breed, was sold to the butcher and another died of bloat. The five remaining heifers are in the college herd, and milk and butter-fat production records for the first lactation are available on four of these animals.

The second bull, Colonel Venus Piebe Paul, No. 331222, was obtained in March, 1928, and has sired 13 daughters, the oldest of which was born in February, 1929.

Skim milk substitutes in calf feeding. The purpose of this project is to determine economical feeds for calves as substitutes for skim milk. These studies will continue through the next biennium.

As a substitute for skim milk two calf-meal mixtures were developed. Calf meal No. 1 consists of the following mixture:

150 parts of ground oats
100 parts of yellow corn
50 parts of wheat bran
50 parts of linseed-oil meal
50 parts of soluble blood flour
5 parts of sterilized steamed bone flour
5 parts of salt

Calf meal No. 2 contained exactly the same ingredients with the exception that 50 parts of powdered skim milk was substituted for the 50 parts of soluble blood flour used in calf meal No. 1.

The following procedure is recommended in feeding calves this ration:

1. One to three days—calf left with dam receiving colostrum.

2. Three days to four weeks—whole milk.

3. Milk feeding can gradually be discontinued beginning at the age of four weeks, except in the case of unthrifty animals which should be fed skim milk from the fourth to about eight weeks of age.

4. At two weeks of age the calf should be accustomed to eating the calf meal. Feed twice per day. When milk feeding is discontinued at five weeks of age, calf should be consuming about 1¼ pounds of the calf meal daily. By the time calf is 60 days of age, it should consume 2 pounds per day.

5. Good hay and water should be available at all times.

6. Pasture, silage, kale, or other succulent feed should be given, if available.

7. At 90 days of age the calf should be fed about three pounds of calf meal, and at 120 days about four pounds per day; at 5 months of age it should receive about five pounds of the meal daily and continue thus until it is 6 months of age.

Cream refrigeration. This is a cooperative project between the departments of Dairy Husbandry and Agricultural Engineering. In the previous work done on this project, it was found that an insufficient number of cows were used to supply a desirable amount of cream for the experiment and a supplementary project entitled "A study of the methods of cooling and storing cream on the farm as they relate to the quality of butter made from it by modern commercial butter manufacturing methods" has been developed. Work on the supplementary project has been in progress during May and June, 1930.

Monthly butter scoring and analysis. The purpose of this study is:

1. To determine if there is any relation between the score of the butter and the number and type of micro-organisms present.

2. To investigate the causes of the development of undesirable flavors during storage for one month at 40° to 50° F. An attempt to classify the most frequently occurring types of bacteria, yeasts, and molds observed in the butter is being made.

The butter used in this experiment is sent to the Station monthly by nine Oregon creameries.

Normal growth studies of dairy animals. This project, which has now been continued for about 11 years, is giving valuable information upon the normal behavior in so far as growth determined by weight, height at withers, belly girth, and heart girth, is concerned. This information is used in comparing the growth records of animals on experimental rations with the normal. During the past year practically all of the young animals in the herd have been on experimental ration; consequently very little data that has been accumulated can be applied to the normal growth curve.

DEPARTMENT OF ENTOMOLOGY

The strawberry crown-moth. The strawberry crown-moth, *Synanthedon rutilans* Hy. Edw. has become a very serious pest of strawberries in Oregon. A great deal of data have been obtained on the life-history and habits of this pest. Especial attention was given to the habits of the adults before

and during oviposition and careful observations made on the development of the larvae and their method of making entrance into the plant.

Preliminary experiments with sprays, both of a poison and fumigant nature were carried on; but so far these tests have failed to develop any chemical that shows promise in control. Preliminary experiments with topping in the 1929 season gave very encouraging results and offer possible aids in control.

A non-technical summary of the results of the investigation to date is reported in Station Circular of Information No. 27.

Strawberry root-weevil. Additional studies on the life-history and control of the common strawberry root-weevils were conducted during the biennium. The experiments were directed mainly against the strawberry root-weevil, *Brachyrhinus ovatus* L. and the rough strawberry root-weevil, *B. rugosostriatus* Goeze. No tests were initiated against the black vine weevil, *B. sulcatus* Fab. because of lack of infested patches suitable for work. Considerable data were obtained on the life-history and destructiveness of these two weevils. Experiments with baits for the two species showed definitely that a bran bait is just as effective as any other of the baits developed for the control of these weevils and that this bait can be made up easily and cheaply by the grower without fear of infringement on patent rights.

Data have been accumulated on the life-history of the two native species of root-weevils found to be doing serious injury to strawberries in the Willamette Valley. These weevils, the decorated strawberry root-weevil *Dyslobus decorata* Lec., and the western strawberry root-weevil, *Dyslobus urisinus* Horn, have shown up in destructive numbers in new localities each year, until at present *Dyslobus decorata* Lec. is probably the most serious root-weevil attacking strawberries in Oregon. The larvae of this weevil work most vigorously in the heat of the summer and kill the plants outright in a very short time. The adults come out early in the spring, during March, at a time when it is very difficult to apply control measures. Very encouraging results were obtained against *Dyslobus decorata* Lec. in the 1930 season, more than 90 percent control being obtained with a bran-sodium fluosilicate bait which demonstrates that under favorable conditions it is possible to obtain a satisfactory control of this weevil with the bran bait developed in Oregon.

A summary of the life-history and control of these weevils will be found in Station Circular of Information 28.

Prune thrips. Preliminary experiments on the control of the prune thrips, *Taeniothrips inconsequens* Uzel, in the 1926 and 1927 seasons demonstrated that in some seasons the thrips are a vital factor in prune production in Oregon. Thrip activity resulted in practically a total failure of the Italian prune crop in the Willamette Valley in the 1927 season. Because of the facts discovered by the preliminary experiments and because of urgent requests of growers for more information on this pest, a major Purnell project was initiated in the spring of the 1929 season. The experiments so far have been directed toward working out a satisfactory spray for the control of the prune thrips, including time and number of sprays, kind and strength of spray, and the timing of the sprays relative to bud development. Experiments have also been carried on to see if the thrip population per bud could be determined above which injury would occur if control measures were not applied, and below which it would not be necessary to apply control measures.

CODLING-MOTH STUDIES

Life-history and seasonal history studies. The seasonal history of the codling-moth was followed carefully by use of bait traps, bands and frequent observations in the field. Peaks of egg laying were observed and the information used in determining the proper spray dates for apple and pear growers in the Willamette Valley.

Substitutes for lead arsenate. The following substitutes for lead arsenate (other than oil) were tested out under field conditions: Sodium fluosilicate, barium fluosilicate, nicotine sulfate, calcium arsenate, free nicotine and Red Arrow insect spray (pyrethrum extract). Of these the calcium arsenate gave as good control as did the lead arsenate. Of the others, the pyrethrum gave the best results. Although not as good as the arsenates, the pryethrum, Black Leaf 40 and the fluosilicates gave sufficient results to warrant further tests with these materials.

Oil sprays for codling-moth control. A number of oil spray tests were tried under field conditions for the control of the codling-moth. Oil emulsion alone and in combination with lead arsenate and with nicotine sulfate was used. Oil emulsion alone gave poor worm control. Oil emulsion plus lead arsenate gave better control than did lead arsenate alone, as indicated by the following example in 1929, a very bad codling-moth year—

Lead arsenate 2 pounds to 100 gallons of water gave 5.2 percent wormy apples.
¾ gallon oil No. 4 plus lead arsenate 2 pounds to 100 gallons of water gave 3.9 percent wormy apples.
Unsprayed check—85.5 percent wormy apples.
Oil alone—13.5 percent wormy apples.
Red Arrow insect spray—6.3 percent wormy apples.

Comparison of varying strengths of lead arsenate for codling-moth control. Lead arsenate at varying strengths up to 6 pounds to 100 gallons was used in field tests. Counts of wormy apples at picking time showed that 4 pounds to 100 gallons in the cover sprays gave better control than did 2 pounds to 100 gallons, but that 6 pounds to 100 gallons gave about the same control as did the 4 pounds to 100 gallons.

Bean leaf beetle. Preliminary investigations of the bean leaf beetle, commonly known as the 12-spotted cucumber beetle, *Diabrotica soror,* were begun during 1929. This is becoming a very serious pest of canning beans. A preliminary study of the life-history of this insect was undertaken and control tests applied under field conditions. It was found that lead arsenate and other poison dusts and sprays acted as repellents and that few beetles were killed by these materials. Pyrethrums when used at proper dilutions killed readily when actual contact with the beetle was made.

Narcissus bulb fly control in Oregon. Experiments for the control of the narcissus bulb fly, *Merodon equestris* Fab., in the field were continued in the 1928 and 1929 seasons on a rather small scale because of lack of funds. In both seasons (1928 and 1929) excellent control was obtained with from four to five applications of bordeaux–oil emulsion sprayed on the base of the plants at weekly intervals during the time that the flies were on the

wing in the field. It is believed that this method of control developed in Oregon has considerable merit because of the fact that the fly is controlled before any injury is done to the bulb.

Onion maggot. Experiments for the control of the onion maggot, *Hylemyia antiqua* Meig., have been continued in one of the principal onion growing districts of Oregon. Bordeaux, bordeaux–oil emulsions, and oil emulsions have been used each season. No results, either positive or negative, were obtained because of lack of sufficient fly infestation either season.

The syneta leaf beetle on cherry. Limited experiments for the control of the syneta leaf beetle, *Syneta albida* Lec., were carried on during the biennium. Special tests were made to determine whether molasses added to standard lead arsenate spray improved the effectiveness of the spray. In the limited experiments tried, the molasses spray was no more effective than the straight lead arsenate–lime spray 4-100. Funds should be available to carry on more extensive tests against this pest because of the serious injury each year to cherries, especially in the Salem district.

Gooseberry insects. The black gooseberry borer, *Xylocrius agassizi* Lec., and the gooseberry and currant maggot, *Epochra canadensis* Lw., continue to be two very serious and destructive insects of gooseberries in Oregon. Time was available to make only hasty observations on these insects in the 1928 and 1929 seasons because of heavy work on other projects and lack of funds to carry on this work. With more interest in the growing of gooseberries in Oregon and a better market in the 1930 season, funds should be made available to make a thorough study of these two insects which have nearly wiped out the gooseberry industry of the state.

The symphilid, scutigerella immaculata (Newp.) in Oregon. This arthropod, commonly known as the symphilid or garden centipede, is increasingly injurious from year to year.

Preliminary observations and control tests conducted during the biennium indicate that none of the known soil fumigants are effective and feasible. Liming the soil up to 20 tons per acre was not effective. Carbon bisulfide emulsion appeared to repell them. On the other hand, crude naphthalene, paradichlorobenzene and calcium cyanide, the latter used at the rate of 150 pounds per acre, were ineffective. Corn soaked in corrosive sublimate and planted near each infested row appeared to give partial control. Additional information upon life-history reveals the fact that the female lays its eggs in broods of 15 to 20 eggs at intervals throughout the season, feeding between each batch of eggs. This habit has suggested clean cultivation as a method of reducing egg laying. Preliminary experiments to test this theory are under way. Funds should be available to carry on more intensive studies of this pest because of the serious damage each year to garden, truck and flower crops.

The native strawberry leaf beetle, timarcha sp., was found to be feeding in large numbers and in some cases defoliating plants in the Union Hill district. Because of urgent request of growers in this district a few preliminary experiments with poison dusts were tried with some encouraging results. Funds should be available to make at least a preliminary

investigation of this native insect that is apparently transferring from its native host plant to strawberry, and which may in time develop to be very serious generally.

Spittle bugs (two species) were found to occur in exceedingly large numbers during the 1930 season. A few preliminary experiments with contact sprays and dusts were made with some encouraging results. Indications so far point to the fact that the spittle bugs were partly responsible for the poor strawberry crop in the 1930 season, and in some cases may have been largely responsible. Further experiments on the control and destructiveness of these insects on a larger scale should be made.

The European or dusky-veined walnut aphis, Callipterus juglandis Frisch. The first appearance of a serious walnut insect pest was reported from the Willamette Valley districts in the vicinity of Dundee in July, 1928, with the request for help in combating it. Between 2,000 and 3,000 acres of walnuts were infested.

This aphis is much larger than the ordinary walnut aphis, *Chromaphis juglandicola* Kalt. Unlike the ordinary walnut aphis, it works entirely on the upper surface of the leaves. As many as fifty aphids were found on a leaf, located in a double row along the mid-rib and facing the stem end. The mid-ribs of the infested leaves were blackened and shriveled. The leaves had a sickly appearance and were blotched with yellow.

The first control measures were applied on July 20, 1928, and on this date the wingless forms were the most numerous, but few winged forms being observed. A 2 percent nicotine dust thoroughly applied between midnight and 8:00 a.m. gave excellent control. This treatment was applied by most of the growers in the infested area. Dust applied during the day was ineffective, due to windy conditions.

This insect has been identified as the dusky-veined walnut aphis *Callipterus juglandis* Frisch, not heretofore recorded as occurring in the United States.

DEPARTMENT OF FARM CROPS

CEREAL AND FLAX WORK

Winter wheat. Varietal trials indicate that of the commercial varieties Jenkin, White Winter, Rink, and Holland are best for Western Oregon. Jenkin is apparently superior to the other varieties on upland soil, while White Winter and Holland are best on bottom-land.

A selection of Jenkin, Oregon 160, continues to be the highest yielding variety. This selection is to be named and distributed in 1930.

Spring wheat. Huston, Marquis, and Zimmerman continue to be high-yielding spring wheat varieties on upland soils. On bottom-lands, three Red Chaff selections, Oregon Nos. 12, 16, and 154, have out-yielded Huston by 10 percent. These selections have the advantage of being white wheats, which are in greater demand by the trade.

Oats. Gray Winter continues to be the highest yielding winter variety and Victory is the most productive spring variety. Varietal trials reveal

that Kanota, a red oat variety introduced in quantity by a milling firm, was one of the lowest yielding varieties grown.

Barley. Winter barley varietal trials have been enlarged. Two selections from O. A. C. No. 7 have proved to be more winter hardy than O. A. C. No. 7. Trials thus far indicate these selections have good productivity and greater resistance to some common barley diseases.

Hannchen continues to be the highest yielding spring barley on upland soils. Trebi is second in yield to Hannchen. A new variety, Advance Pedigree, grown during the biennium, appears very promising. On bottomlands, O. A. C. No. 7 is the high yielding spring barley, out-yielding Hannchen about 5 percent. Withycombe, a hooded variety from the Union Station, has also slightly out-yielded Hannchen on bottom-land. This variety seems especially promising under favorable conditions and is the highest yielding hooded barley yet grown.

Cooperative cereal trials. During the biennium, an extensive cereal varietal trial was carried on in Klamath county in cooperation with the Extension Service. A smaller trial was also conducted in Coos county. The Klamath trials show Federation and Onas wheats to be much higher yielding than the varieties generally grown. Markton is the highest yielding oat variety grown and is much superior to the local strains. The barley yields were more variable, but they indicated that Trebi, O. A. C. No. 7 and Hannchen are highest yielding varieties.

The trials in Coos county indicate that O. A. C. No. 7 is well adapted as a spring barley variety.

Fiber flax. Fiber flax work is carried on in cooperation with the Office of Fiber Investigations, Bureau of Plant Industry. This office has furnished a number of new strains which are much superior to the common Blue Dutch strains grown commercially. The J. W. S. variety has proved to be practically equal in yielding ability and length of straw to the best of these new strains. Preliminary retting trials indicate this variety to be slightly inferior to the new strains in percentage of fiber.

The control of weeds is the most important cultural problem. Fiber flax is best grown in a rotation which includes a leguminous crop and in which flax appears only every third or fourth year.

Further investigations should include detailed studies on percentage and strength of fiber, and should be directed toward standardizing and cheapening retting and scutching operations.

Oregon is the only state in the United States producing fiber flax in commercial quantities for spinning. The work with fiber flax is of such importance that the Bureau of Plant Industry is considering the concentration of the fiber flax investigational work at Corvallis.

Seed flax. The acreage of seed flax has increased materially during the past year, due largely to the high prices for flax and the low prices for wheat in the spring of 1930.

The only seed available in quantity was that from Montana and from Argentine. The varietal trials with seed flax indicated the superiority of commercial Montana strains over commercial Argentine strains, so that

Montana seed stocks were obtained by the linseed-oil companies for distribution to farmers. Seed for approximately 25,000 acres of seed flax was distributed by one firm alone in the spring of 1930.

CEREAL BREEDING AND CORN WORK

Nursery. The nursery includes about 3,600 rod rows and 2,000 head rows of selections and of hybrid material. Some nursery material is also carried for Federal pathologists located elsewhere. The nursery work is of such importance that the Cereal Office plans to cooperate in the project by supplying the services of a trained agronomist and plant breeder in the near future.

Wheat. Of particular importance to plant breeders has been the discovery of a number of physiologic forms of smut. These forms have been found infecting wheat in various sections of the Northwest. Since this discovery was made at Moro in 1927, considerable progress has been made in classifying the various forms of smut and the resistance of varieties to them. The presence of these different smut forms greatly complicates the plant breeder's problem, but a knowledge of them enables him to test new strains for smut resistance much more thoroughly.

The nursery work with winter wheat includes a large trial of new varieties, selections, and hybrids. Selection and breeding of Jenkin and other wheats to obtain greater hardiness, higher yield, and smut resistance is under way. Attempts are being made to produce a higher yielding white spring wheat and to obtain greater freedom from disease, particularly leaf rust.

Oats. Hardier strains of Gray Winter oats are being tried. Attempts are also being made to get greater strength of straw. A large number of new spring oats have been introduced, among them some very promising ones from Sweden and from England. Several oats nurseries have been planted in the Coast counties in order to find spring oats varieties resistant to stem and crown rust.

Barley. Many selections of barley have been made with the idea of obtaining a winter barley of greater winter hardiness than those now being grown commercially in Western Oregon. Many selections and hybrids of spring barley are grown, particularly of the hooded and smooth awned sorts.

Corn. Corn trials demonstrate the value of Minnesota No. 13 as an early maturing corn for Western Oregon. McKay dent corn continues to be the highest yielding silage variety. The corn acreage of the state is expanding gradually and there is an increasing demand for corn information.

Trials with organic mercury dusts as seed treatment have been expanded. The use of land-plaster as seed treatment continues to show superior results to the commercial preparations.

Some inbreeding work with corn has been started with a view to developing high yielding first generation hybrid strains of corn for Oregon conditions.

Potatoes. The method of handling cut potato seed is an important factor in obtaining stands of potatoes. Seed which is kept in a cool and moist condition for forty-eight hours or more after cutting is better able to withstand unfavorable conditions than freshly cut seed. Freshly cut seed is more easily attacked by soil fungi and is more easily injured by sunlight than seed which has been cut for the longer period. Three hours' exposure of freshly cut seed to sunlight reduces the stand from 30 to 50 percent.

Better results are normally obtained from early or late planting than from planting on intermediate dates. A lack of moisture is the important limiting factor in potato growth. Early planted potatoes mature during dry weather; late planted potatoes mature after the first fall rains.

WEED ERADICATION

Considerable experimental work has been done the last two years in the use of chemicals in weed control. Most of this work has been directed toward Oregon's most widely distributed perennial weeds, Canada thistles, morning-glory and quack-grass. Other plants with which trials have been made are bracken fern, horsetail rush, wild blackberry, lupine, wild gourd, poison oak, burdock, and snowberry.

The chemicals which have been used are sodium chlorate, Atlacide, a patented commercial chlorate, sodium arsenite, carbon disulfide, K.M.G., and borax. Of these chemicals sodium chlorate and Atlacide are the most promising. The use of the others has been discontinued because of their being high priced, poisonous, and ineffective.

At the present time further work is planned with chlorates. Rate of application, season of the year to apply, and comparison of spray with dust are problems for solution.

Atlacide and sodium chlorate used at the rate of 3 pounds per square rod as spray or dust appear to be effective on Canada thistle, morning-glory, and quack-grass. Heavy rainfall in Western Oregon, leaching herbicidal materials from the soil, complicates the difficulties of successful eradication.

RESEEDING OF BURNED-OVER LANDS

In 1927 experimental seedings of grasses were made on burned-over land in the higher part of the Coast Range, which represents a large area of Western Oregon. The objective of these tests was to obtain forage plants which could compete with bracken fern now dominating the area.

Soil conditions are unfavorable due to high acidity, low nitrates, and low lime content. Plants must also withstand summer drought. Burning in late August with immediate seeding in the ash has given better results than other times or conditions tried.

Sixteen types of grasses, two vetches, three clovers, alfalfa, and sweet clover have been planted in this area. Four grass mixtures have been used. Grasses proving to be best adapted are orchard, redtop, English rye, timothy and Reed canary. Vetches, alfalfa, and the clovers, with the exception

of white clover, have not been economical. Winter killing through soil heaving is a serious problem with young seedlings.

Further work particularly in regard to mixtures seems necessary.

FORAGE

This project is cooperative with the Bureau of Plant Industry, and is the largest project of the department from the standpoint of investment.

Legumes, which are needed on more of the farms and in larger acreage, continue to be a major subject of investigation.

Vetches. The Station distributed during the past year a selection of Hairy vetch less inclined to shatter than the types commonly grown.

Two early maturing types of Common vetch, No. 13430 and No. 16462, continue to show promise as green manure crops in California. Both are early maturing types. Noena vetch is showing promise on the Coast for pasture and hay use.

Hungarian vetch, introduced by the Station some years ago and quite resistant to aphis, now has a wide distribution in the Willamette Valley, comprising approximately 80 percent of all varieties grown.

Hairy vetch continues to be grown on a moderate scale as a seed crop for sale in the Southeastern States.

Austrian winter field pea seed is continually increasing in demand in the Southeastern States in those areas where winter hardiness is required. This crop is suited to many of the medium heavy soils in the Willamette Valley.

Recent experiments indicate that Austrian winter field peas do best on a well-prepared seed-bed and are not well suited to stubbling in. Their chief weaknesses are (1) approximately as susceptible to aphids as Common vetch; (2) subject to attack by pea-weevil, which requires prompt threshing and immediate fumigation thereafter. The acreage is increasing rapidly. In 1930, 6,000 acres are being harvested for seed.

Alfalfa. The acreage in alfalfa is increasing rapidly and excellent satisfaction is obtained with it. Varieties in the variegated group continue to show best, with Grimm the most outstanding of these varieties commercially available. Strain trials of Grimm from different states show little difference. Grimm and related varieties appear resistant to stem rot, which probably accounts for their popularity in our mild climate.

Rate- and method-of-seeding trials of alfalfa indicate that good stands may be had with small quantities of seed. It appears that favorable conditions for growth, such as a good seed-bed, successful inoculation, and good moisture and plant food conditions, have more to do with obtaining a good stand than small variations in the amount of seed.

Good, thick, vigorous stands seem necessary for continued production of high yields.

Red clover. The strain trials of Red clover are being continued. Chilean strains are high forage producers. Italian strains are low. Local Oregon strains are very satisfactory.

The Tennessee anthracnose-resistant variety seems well suited to our conditions as a seed crop. If seed produced in Oregon maintains its disease-resistant qualities when returned to the disease-infected area, there is a possibility for a large industry in the production of this crop. Various lots of Oregon Red clover seed are being tried out in eastern experiment stations to locate hardy strains suited to the north central states' conditions. When varieties suited to their conditions are selected, Oregon production can be standardized. Varieties or strains which have proved satisfactory will command premiums instead of the present tendency to take discounts.

Hardy Ohio Red clover initial seedings were made in 1930. This Red clover shows promise of improvement over the ordinary strains now grown in Western Oregon.

Red clover may be seeded either in the late winter or fall grain, or it may be sown in a well-prepared seed-bed in the spring. The latter method is recommended mainly where lands are weedy, or on run-down lands where stands are difficult to obtain.

Soy-bean. Soy-bean work is being continued in the hope that soybeans may supply an annual leguminous forage and rotation crop suited to planting after it is too late for vetches or peas. Dunfield and Wea are two promising new varieties. Also, several selections show much promise.

Zigzag clover. Progress is being made on efforts to develop methods that will bring this perennial clover into commercial seed production.

Sweet clover. A sweet clover resistant to stem rot is being developed, and in 1930 one acre of an especially stem-rot resistant strain will be harvested for seed. This disease is a limiting factor in sweet clover production in Western Oregon.

Strawberry clover. While not a success as compared with other clovers in this area, strawberry clover is being observed and studied in some of the alkali sections where its production indicates it to be an excellent alkali pasture clover and to have turf-forming possibilities on alkali soils that may be kept well watered.

Grasses. Numerous nursery, plot, and field trials are being carried out with grasses to determine their suitability to conditions, their forage value, and seed production possibilities and methods. Among these, the outstanding forage grasses include English rye-grass, rust-resistant timothy, meadow foxtail, Kentucky blue-grass, orchard-grass, tall oat-grass, and redtop. Among the grasses that are less common but that show possibilities for forage and seed are Reed canary grass, tall fescue, Chewing fescue, and a strain of Harding grass.

Particularly interesting from the standpoint of pasture work is the performance of Kentucky blue-grass, redtop, meadow foxtail, English rye-grass, tall oat-grass, timothy, and orchard-grass.

A new grass nursery, established in 1929, consisting almost wholly of new importations from Africa, indicates development possibilities of several improvements from the forage standpoint.

Pasture. Land for conducting proper pasture trials at the Station is not available. Field studies indicate the following:

1. The pasture problem in Western Oregon is probably the biggest agricultural problem.

2. Establishing pasture on logged-off land is a large part of the problem.

3. Economical pasture establishment demands that it be done on a good "first burn."

4. Numerous observations show that good stands may be easily obtained by fall sowing on a good burn.

5. To be permanent and resist encroachment from brush the pasture mixture must include sod formers and the pasture must be kept pastured.

6. Permanent legumes seem important from the standpoint of productiveness, fertility maintenance, and quality of feed. Burr clover, Ladino clover, and common White clover are excellent.

7. Irreparable damage has been done many loggings through losing the long-time effects of a first burn by sowing cheap and temporary "burn" mixtures.

8. It appears that rotation grazing which will permit close pasturing is desirable.

9. Unseeded, burned-over land or land seeded to the temporary burn mixtures quickly comes back into brush.

10. The Station's recommended pasture mixture for burns is giving excellent results.

Grass seed production work is being studied with tall oat-grass, orchard-grass, meadow foxtail, timothy, Kentucky blue-grass, the rye grasses, tall fescue, Harding grass and Chewing fescue.

Studies of different bent and other turf-forming grasses are being continued.

Lemmon alkali grass is a promising new Eastern Oregon grass observed in Morrow county. It has forage and turf possibilities.

ROOT CROPS

Root trials show turnips and rutabagas unsuited to Corvallis conditions. The New Zealand White Belgian carrot is the most promising variety of carrots. Mangels are the outstanding root crop for Western Oregon. Half Sugar, Danish Sludstrup, Mammoth Long Red, and Red Intermediate are good varieties. Work is being carried out with different varieties of sugar beets.

MISCELLANEOUS FORAGE WORK

A study is being made to determine the best state of maturity for the harvest of various grass and legume crops.

The nursery is a means of proving various introductions suited to more extensive trials and on the other hand eliminates enormous numbers of forage crops unsuited to the conditions.

Among the more outstanding bits of nursery work are trial studies of the White French Jerusalem artichokes; the cold-resistant variety of Bermuda grass, strains of Reed canary grass, and meadow foxtail that are rather non-shattering in habit, and strains of different bent grasses and their variations.

Jerusalem artichoke variety, cultural and utility trials are being extended. These artichokes show much promise of becoming a good cash crop on fertile easily cultivated lands. They are being used in increasing quantities for human food and stock feed.

LINN EXPERIMENT FARM WORK

On the Linn Experiment Farm, crops are being grown to determine the economy of the application of water, the effect of rotation, and the effect of various fertilizers. Potatoes, clover, and barley are grown in rotation. To date it has not been profitable to allow clover to produce more than one crop. The work of the clover root-borer and the competition of weed growth are largely responsible for this condition.

Irrigation has materially increased the yields of potatoes and of clover seed. No irrigations have been made to the barley in the rotation. Water applied to young clover following the removal of the barley is beneficial in establishing stands of clover.

Alfalfa is grown alone on another area. A part of the alfalfa land is utilized for an alfalfa varietal trial.

SEED LABORATORY

During the biennium the Station seed laboratory made a total of 1,892 purity tests, 1,909 germination tests, 139 examinations of samples, and 40 identifications.

For the first year of the biennium 1,772 tests were made, and during the second year, 2,208 tests. Many more tests would have been made during the past year had the facilities of the seed laboratory permitted. A growing seed industry is responsible for the increased demand for seed laboratory service. Both growers and dealers are using the seed laboratory. A marked increase in the demand for this service is anticipated.

DEPARTMENT OF FARM MANAGEMENT

Cost and efficiency in Oregon prune production. This study covers the cost of production and the internal organization of the prune farm over a period of four successive years on the same farms, embracing a total of 8,748 acres of bearing prunes in Western Oregon.

The study gives a complete picture of the cost of production in normal, low- and high-yield years, and an analysis of the factors in farm organiza-

tion and management within the control of the grower which influence cost and profit. The study shows that as a whole prune production is a stable and desirable enterprise for this region.

Manuscript for final publication of the results of the study is under preparation.

Cost and efficiency in Rogue River pear production. A three-year study covering the cost of production of 874,815 boxes of pears during the years 1924, 1925, and 1927, and the analysis of the factors controlling costs was completed during the biennium.

The study shows pear production to be one of the most profitable enterprises in the entire state when plantings are properly located and efficiently managed. It brings out the major factors which growers must watch closely to maintain profit against increasing competition.

The results of this study were published as Oregon Station Bulletin 267, summarized elsewhere in this report.

Cost and efficiency study of Oregon forage enterprises. A study covering the cost of production over a period of three successive years, 1925-1927, of a total of 134,000 tons of all of the major forage feeds of the state, with the exception of pasture. This study enables livestock growers and specialists to determine the best feeding ration from the economic standpoint, and to determine those forage crops which are most profitable to produce. It shows the most efficient methods and machinery for forage production, harvesting, and storing. In addition, the project covers a study of the cost of horse labor on the different major types of farming in the state.

Detailed results of this study are presented in Station bulletins 241, 248, 250, and 251.

Cost and efficiency in commercial egg production in Oregon. This study covers cost of production on the same farms over a period of three successive years, 1926-1928 inclusive, in the four major poultry sections of the state on a total of 271,337 hens. It gives a clear and reliable picture of this important enterprise in all parts of the state, indicating definitely the controlling factors influencing costs and profits. Analysis of the results of the study indicates the adjustment in farm organization and operation which should increase efficiency and reduce cost, thus bringing the poultry farmer a better net income.

All field work on this project was completed during the biennium, annual progress reports were issued, and preparation of the final publication is under way.

Cost and efficiency study of Willamette Valley strawberry enterprise. This study covering 633 acres of bearing strawberries during the years 1925-1926, gives a satisfactory picture of the cost of production, and an analysis of the factors influencing cost. The study shows the enterprise to be a profitable one where the natural advantages of the Valley are utilized, and where efficient methods are employed.

During the biennium the study was concluded and published as Oregon Station Bulletin 245, a summary of which is given elsewhere in this report.

Oregon apple price study. This study covers the prices received on 9,607,119 boxes of graded and packed apples in the seven important apple districts of Oregon over the five-year period 1922-1926. The quantity of apples included in this study constituted 42 percent of the total commercial apple production of Oregon for the five-year period. A careful analysis of prices by variety, grade, size, year, and district is presented. The study was concluded during the biennium and published as Oregon Station Bulletin 244, which is summarized elsewhere in this report.

Dairy farming cost and efficiency study. The first year's field work of a two-year study was completed covering the taking of complete farm records from 578 dairy farms in all the major dairy sections of the state. It is expected that the extent and thoroughness of the study will not only give a very accurate picture of the cost of dairy production and the comparative cost of production by regions, but the factors influencing and permitting the reduction of costs. In addition, improvements in the internal organization of the dairy farm and the relative advantages of different types of dairy farming under different conditions will be determined.

Walnut enterprise cost and efficiency study. The first year's field work of this two-year study covering the cost of production on 130 bearing orchards, and the cost of establishing fifty young orchards was completed during the biennium. It is believed the study should determine the remedies for any weaknesses in the operation and management of this important long-time enterprise. The study is being conducted in cooperation with the federal Northwest Nut Experiment Station.

Grain handling and storage study. This study was initiated in June, 1930, in cooperation with the United States Department of Agriculture and the state experiment stations of Washington and Idaho. Its purpose is to determine the cost and the most efficient methods of handling wheat in the harvest field and in storage in the dry-farming sections of the three states, particularly in relation to the relative costs and advantages of sack and bulk handling, and storage. From 200 to 300 records are to be obtained in the three states.

Relation of farm taxes to farm income. This is a compilation and analysis of data taken from sixteen different farm surveys covering 2,144 farm records during the years 1914-1927 by the department of Farm Management, as cooperation furnished to the Federal Forest Tax Inquiry.

Applied farm organizations. This work constitutes a continuing project in experimental farm management begun by the department many years ago. Complete farm reorganization plans were prepared for ten different farms during the biennium, making a total of approximately 100 farms in different parts of the state for which reorganization plans have been prepared. As far as time permits, the department is following up these farms and helping them in carrying through the reorganization plans worked out, and keeping a record of the effects on income. In this way at very little expense to the Station experimental evidence is being obtained as to the value of the findings of farm management investigations, when applied to the organization of the whole farm in the hands of the practical farmer. It is believed by the department that this project might be made extremely valuable if more time and funds were available for following it through.

Cost and efficiency study of farm buildings. This is a continuing project begun many years ago designed to develop the most economical and efficient types of farm buildings of all kinds. Complete plans and construction details have been worked out and widely distributed to farmers, records of cost of construction kept, and means of improving their efficiency studied after the buildings have come into use. This project also is experimental farm management. A great deal of very valuable information regarding the subject has been accumulated and is ready for publication when funds are available.

DEPARTMENT OF HOME ECONOMICS

Agricultural Experiment Station work in Home Economics which was started in 1925 was continued through the biennium, the major work consisting of a study of the use of time by farm homemakers.

Present use of time by farm homemakers. The object of this project was to determine the factors influencing the distribution of time in representative farm households and the amount of time devoted to different kinds of work. It was undertaken primarily as a problem-finding study, with the expectation that the results would form the basis for a program of household management research dealing with fundamental problems of Oregon farm homemakers.

The analysis is based on 547 records, each record consisting of a detailed diary kept for a week of normal household activity, with such supplementary information concerning the household as was needed to analyze them. Rules developed by the Bureau of Home Economics were used in summarizing these records preliminary to their use in the various analyses made, in order that results for Oregon might be closely comparable with those of similar studies in other states.

The major results of the study which have been published deal with the use of time of the homemaker and include the chief facts concerning the amount, nature, and sources of help received. Subdivisions of this report have been completed with the expectation that they will serve as source material for publications and as reference material in connection with other projects as follows:

1. The length of the homemaker's work day (Time distribution within the week).

2. Putting up school lunches as an item in the farm homemaker's work schedule.

3. Time costs of household operation.
   a. Total time used; relation to time spent in various aspects of homemaking; differences among households.
   b. Time spent in meal preparation.
   c. Time spent in meal clearing.
   d. Time spent in cleaning.
   e. Time spent in laundry.
   f. Time spent in the needlecrafts.
   g. Time spent in the care of members of the household.

The results of the Oregon time study are of significance to other states since they define the time distribution pattern which represents the cost, in hours of labor, of maintaining the American rural standard of living. Farm incomes in the various states do not differ greatly; farm families eat and wear and use much the same things in much the same ways; consequently, the job of the farm homemaker is much the same in one state as in another. As a result of this common interest in the study two reports were presented at the annual meeting of the American Home Economics Association. One article was prepared for *Farmer's Wife*, a magazine of almost one million circulation in the Middle West, and one for the *Journal of Home Economics*.

A report was prepared for the Electrical Equipment Short Course conducted in February, 1930, by the School of Home Economics at which Home Service representatives of various electrical utility companies were present.

Further studies needed are of two types: (1) those intended to round out our information concerning the problems of Oregon farm homemakers, and (2) those which are designed to be of direct value in helping homemakers to meet specific problems.

The chief needs in the first group are: Seasonal variations in housework which are a result of the demands of farm enterprises.

"Specific problems" of households fall into four classes:

1. Raising the standard of living through better management of time—better-cared-for children; better food; higher standards of cleanliness; a greater degree of peace and comfort, etc.
2. Safeguarding the homemaker, particularly the mothers of little children, from the effects of too long hours, too many hours of heavy physical labor, etc.
3. Economy in the use of money and time.
4. Productive use of time not needed for the household.

Studies having as their object the meeting of specific problems are:

1. The establishment of "standard practices" for executing the various units of household work—child care, cooking, cleaning, etc.; equipment, method, and a time and energy norm.
2. The fitting of time demands for these various units into schedules for type household situations.
3. The development of housing arrangements and equipment for farm use.
4. Time and money costs of alternative methods of caring for household needs.

   Example—Laundry done at home as compared with the cost of commercial service.
5. Opportunities for the homemaker in work other than homemaking.

DEPARTMENT OF HORTICULTURE

The experimental work of the departments of Pomology, Vegetable Gardening, and Horticultural Products, in the Horticultural Group, has been confined during the past biennium to carrying out and expanding problems which had already been started at the beginning of this period.

In Pomology, irrigation of small fruits is beginning to show pronounced results and will be continued for several years longer. Breeding of small fruits, the strawberry especially, has brought out a few very promising seedlings. The excellent cooperation given by the United States Department of Agriculture is producing fine results in obtaining material for this work from distant and important sources.

Investigations into the optimum methods of storage and of ripening pears at the Home Station, at Medford, and in New York City, have led to some conclusions very valuable for the pear growers of the state. These experiments will be continued for at least another year.

The irrigation of certain vegetables under the soil conditions found on many of the Willamette Valley vegetable farms has shown remarkable results in quality, yield, and prices received for the products.

In Horticultural Products the main problem has been to devise a relatively simple method of grading Italian prunes so that factors of quality and healthfulness might take their rightful place along with size and appearance. This result apparently is in sight and it is hoped the task will be finished within the coming year.

Following is a more detailed statement of the investigational work by projects:

Culture and testing of perfume roses. This project, begun in 1927 in cooperation with the office of Drug, Poisonous, and Oil Plants, Bureau of Plant Industry, United States Department of Agriculture, aims to determine whether perfume roses can be grown profitably here in competition with districts in Europe where the industry has long been established.

The crop of rose petals during the summer of 1929 was the first large enough to make harvesting and extraction worth while. Harvesting lasted for approximately one month from June 10 to July 12, 1929. More than 1,000 pounds of rose petals, mostly of the Ulrich Brunner variety, were picked. Both the distillation and the extraction by petroleum-ether methods were tried with poor results from the former and fair results from the latter method.

Cold weather in January, 1930, injured the tops of most of the varieties to some extent and injury was severe on nearly two-thirds of the 66 varieties being grown. While nearly all these injured varieties sprouted up from basal buds and bore some flowers, the crop was very much below normal. There were enough blossoms produced, however, so that perfume tests were made of some 14 varieties.

While results of the tests of 1930 are not yet completed, the work of 1929 indicates that roses producing satisfactory quantities of perfume of good quality can be grown under Western Oregon conditions. Whether or not rose perfumes can be produced to compete with foreign countries remains to be shown by further studies.

Blueberry trials. In the fall of 1928 some fifteen named varieties were transferred from a sandy peat soil at Waldport to a location less frosty at Taft. These plants have become established in their new home and are doing well on a rather sandy peat soil.

Trials with hardwood cuttings set out early in the spring in moist peat indicate that a satisfactory percentage of cuttings will strike root and grow under favorable conditions. Unfortunately lack of funds has made it impossible to develop this phase of the experiment as far as it should go.

Cost of pear production in the Rogue River Valley. The field work on this project has been completed and bulletin published. Report upon this project will be made by the department of Farm Management.

Improvement of old prune orchards. During the biennium, work has been continued in an attempt to determine methods for improving yield of prunes in two old prune orchards in the vicinity of Salem, which have been bearing poorly for several years. The improvement has consisted of careful pruning, mostly the thinning out type, combined with the application of various fertilizers and the turning under of cover-crops upon certain plots. Careful record has been kept of the yields upon these various plots. During the fall of 1929 the harvesting records on one of these places were entirely nullified by the deliberate carelessness of the picking foreman. It was thought best, therefore, to discontinue work in this orchard for the year 1930.

Up to this time, no marked benefits have been seen from the treatment described. There was, however, a very fine growth of young wood during the year 1929 and an excellent blossom in the spring of 1930. The cold weather of last January, coupled with the long drouth of the previous fall, seemed to have devitalized the young fruit so that practically 90 percent of the fruit dropped from the trees. Results for the past year, therefore, look anything but promising. It is expected that this experiment will be carried on for another year or two if funds permit.

Studies on growth correlations and reproduction—

1. The growth correlation studies on the apple and pear tree by means of ringing, defoliation, disbudding and notching, were practically abandoned in favor of the work on Okra.

In August, 1928, several series of Okra plants, receiving different experimental treatments, were brought under close observation. Vegetative growth and sexual reproduction were found to be extremely delicately balanced in this plant. So much so, that the energy normally going into a flower bud during the last 24 hours before opening, or the energy normally expended during the 24 hours after opening a blossom, or the energy in other similar activities, could easily be detected by noting the response at the main growing point of the plant. These preliminary results seemed to justify the previous hope that in Okra might be found a plant in which certain phases of growth correlation could be followed much better than in apple and pear shoots.

Other series of Okra have been under observation since January, 1930. This phase of the work will be continued during the coming year. In addition to the measurement of external responses to different treatments, an attempt will be made to reconstruct to some extent the internal chemical picture accompanying these responses.

2. There has been a continuation of the work on the behavior of phloridzin in the apple tree. The weight of the attack, however, has shifted from the study of normal conditions in the orchard toward a study of the responses of phloridzin under the influence of a large number of organic compounds which have proved effective in breaking the rest periods and stimulating growth in other tissues. Some very interesting responses have been recorded and they seem to throw some light upon the function of phloridzin in the life processes of the apple; yet so many factors are involved that it has not appeared wise to draw any sharp conclusions. In order to test the possible significance of some of the chemical differences recorded between certain series, a rigid study of the accuracy of sampling and the probable error of the chemical procedures was made and the results of this strongly indicate a low probable error as compared with the chemical differences recorded.

Other investigations—

1. Effects of Light on the Rooting and Growth Cuttings. It was found that light greatly influenced the regeneration activity of cuttings.

2. An attempt to hasten the After-ripening and Germination of the Sweet-brier, Rosa Rubiginosa. About 200 organic chemicals or combinations were tried in the endeavor to hasten the after-ripening of plant embryos. There was no evidence of stimulation by any of the chemical treatments. This is in striking contrast to the usual effects of the same or similar organic substances on dormant buds. Evidently there is a fundamental difference between the two types of dormancy.

3. The Manioloff Reaction and its application to the Determination of Sex in Plants. This reaction, originally applied to the determination of the sex of human blood was here applied to the seedlings of dioecious plants. In certain plants the reaction seems capable of giving 90 to 95 percent correct answers.

4. The study of the Relative Transpiration and Resistance to Loss of Water (under extremely severe conditions) by Different Varieties of Apple Trees. This work was commenced a few weeks ago and is to continue throughout the present summer.

5. A "water culture" Study of the Strawberry to Determine the Relation of Certain Nutrients to Runner Production. This phase of the general problem was started last March and is being continued through the summer.

Spray residue removal. A test to determine the effect of washing on the keeping quality of apples was conducted in 1928. This included six varieties of apples and seven commercial washing-machines of various types. The results of this test have not been published, but in the main, they indicate that the commercial types of washing-machines using hydrochloric acid are generally satisfactory so far as injury to the fruit is concerned. Work was continued in 1928 on relation of washing to calyx injury. The results of this phase of the work are given in Oregon Station Bulletin 242. Some work was done on fruit washers and a new and improved home-made washer is described in Oregon Station Circular 92.

Harvesting and handling of fruits. During 1929, tests were carried on with the aim of utilizing the flotation method for the determining of

maturity in cherries for fresh fruit shipment. The results, however, were disappointing. Tests relative to the harvesting, storage, and shipping of fresh prunes were continued. The scope of the work was increased so as to include chemical studies of the ripening process and of the changes occurring in storage.

A comprehensive test of the chemical changes occurring in pears after picking was undertaken with the aim of finding some index that might be used as a guide in determining when pears in storage are nearing the end of their storage life. These tests showed that in the main, pears lose their starch content shortly after they are placed in storage at 32° F. Their sugar content goes up in cold storage but makes its greatest increase after the fruit is removed to higher temperatures. The acidity of pears decreases in cold storage and also after removal from cold storage. Acid aldrohyde accumulates in the tissue of pears as the fruit reaches the end of its life. Even though pears lose in both weight and volume while in storage, the water content remains practically the same throughout the storage period.

In the spring of 1930 tests were undertaken to determine the effects of time of picking and storage on the quality and chemical composition of strawberries.

Work for Medford pear growers. During the period from September 15, 1929, to July 1, 1930, one member of the department was absent on work for the pear growers and shippers of Medford, Oregon. This work had to do with the handling of pears on the Eastern markets. The work was conducted at Chicago, Detroit, and New York City.

Irrigation of small fruits. The irrigated trials, started in 1926, are now beginning to show results. In 1929 the percentages of increase in yield of berries were as follows:

	Percent
Marshall strawberries	67.9
Loganberries	88.0
Red raspberries	88.8
Black raspberries	57.0
Evergreen blackberries	144.0

These yields were obtained by increasing the bearing surface to the greatest amount at which a satisfactory size of berry was still maintained. This increase in yield was due to greater size of berry as well as greater numbers of berries. With Ettersburg 121 strawberry, there was a decrease of 9.3 percent. Irrigation has not paid with this variety.

The increase in size of the berry itself was shown where the same length of cane was left under irrigated and non-irrigated conditions. An increase in size of the individual berries was 13.2 percent for loganberries, 29.1 percent for black raspberries and 97.1 percent for Evergreen blackberries. The greater development for the blackberries may be due to the fact that they ripen later than the others. The moisture supply in non-irrigated soil in 1929 was very low so the blackberry would probably suffer more than the earlier maturing kinds.

As a result of irrigation, it was possible in 1927 to set a new field of strawberry plants after an early crop had been harvested, the planting being done August 15. One of the varieties tried, O. S. C. No. 12, gave the

best results, yielding at the rate of 5,200 pounds per acre in 1928, and in a second planting, made August 1, 1928, 6,000 pounds per acre in 1929.

The effect of irrigation on the time of ripening has been somewhat variable, but has not particularly delayed the beginning of harvest of any berry. On the first picking of Evergreen blackberries in 1929, 7 percent of the total crop was harvested from the irrigated plot and 5 percent of the total crop from the non-irrigated plot. Twenty-eight days later the irrigated plot had produced 79 percent of the total crop and the non-irrigated 72 percent of the total crop. Irrigation has prolonged the harvesting of strawberries by sizing up the late berries.

With the possible exception of black raspberries, the effect of irrigation on the canning quality of the berries has been beneficial. In the black raspberries, the color shaded toward a lighter purple where irrigated. The flavor of all the irrigated berries was milder and more pleasing. The irrigated red raspberries were of a firmer texture and brighter color than the non-irrigated.

Breeding and testing small fruits. In 1929, 350 varieties and selections of strawberries were tested out. Only 6 were held for further observation. In 1930, 90 new kinds were grown. Possibly one extra early kind has been found in this collection. A few of them are being held for observation. Of the 40 varieties of cane fruits, 1 new raspberry looks promising.

In 1929, 1,200 strawberry seedlings were fruited and in 1930, 20,000 were fruited. Two hundred are being held for further testing. There are now 22,000 seedlings in the field to fruit in 1931. More than 2,000 cane-fruit seedlings are being grown for future fruiting.

O. S. C. No. 12, a seedling under test for several years, is proving satisfactory in many sections. It is a good canning berry. For fresh market, the size, color, and quality is creating a demand. It will be named and patented.

Cultural problems. Shallow cultivating of strawberries has proved more satisfactory in producing consistent yields than deep cultivation. Leaving the runners to develop greatly reduces the size of plant and crop for the following year. Plantings have been made to test out the desirability of topping strawberries, and to determine the effect of mulch paper and close planting.

Greenhouse tomatoes. Studies have been continued for a number of years relative to the use of greenhouse tomato varieties that are, to a high degree, self-fertile. These were conducted to ascertain the relative value for commercial use of such varieties as Best of All, Princess of Wales, Kondine Red, Satisfaction, and Perfection, all of which are of the English type. Three American types were also used this season; namely, Crackerjack, Forcing Marglobe and Osgoode. Of these varieties, Best of All and Princess of Wales of the English varieties and Crackerjack of the American are undoubtedly the most favorable so far.

A new device used to pollinate tomatoes known as the electric pollinator was developed by an Oregon grower recently. Inasmuch as some form of pollination is necessary in order to insure a satisfactory fruit set, this method is under trial at present to determine its usefulness to the commercial grower.

An experiment has been in progress relative to the influence of fruit cluster thinning on the total yield and percentage of extra fancy grade fruit. Lack of sufficient data at this time prevents arriving at a definite conclusion. It is planned to develop this work further with the view in mind to establish a definite thinning program.

Seed strain tests—

Beets. Studies have been made for several years of different strains of beets for canning purposes. Cannerymen are desirous of obtaining a strain of the common beet used for canning; namely, the Detroit Dark Red, showing as little zoning or ringing of light colors as possible. The object of this experimental work has been done to contrast the relative value of different strains of this variety and to investigate the factors that affect the color of the roots for canning. Of the different strains tested, a wide variation in the percentage of usable roots is apparent.

Beets subjected to irrigation produced from 73 to 88 percent desirable roots and those that were not irrigated, 69 to 82 percent desirable color.

Other factors such as plant food nutrients, soil types, and season of growth are under trial at present and will be continued to determine their influence in color.

Carrots. Studies have been made of several carrot strains for the canning trade. Undesirable carrot strains have lighter centers or even green cores in comparison to the outer orange-colored portion. Various strains of Chantenay have been tried and at present a red coreless carrot developed by one of the seedhouses may prove to be a desirable type.

These tests are to be continued along the same lines as the beet-color investigations in order to determine the influence of certain factors on the color of carrots.

Irrigation of vegetables. The work during the seasons of 1928-1929 consisted of a continuation of that previously started—irrigation cost studies and yields of vegetables including sweet corn, beans, squash, peppers, and cabbage. Electricity costs have been very similar to those reported in 1927-28, approximately $1.00 per acre per month for the irrigation season, beginning in May and ending early in September.

The individual sweet corn ears were 70 percent heavier in the irrigated plots; also irrigation increased the total yield by 140 percent.

Irrigation of snap beans (for canning), late cabbage, and peppers resulted in an increased production of 74, 45, and 98 percent respectively.

The results that have been obtained in these studies indicate that for most vegetables, irrigation will greatly increase the yield and that the irrigation may be done economically using electric power for pumping water.

This season, 1929-30, was particularly dry, especially toward the latter part, so that the average cost per acre was $7.15 compared with $5.23 for the previous period of 1928-29.

Crop	Yields, Costs, and Profits (Acre rate)				Percentage increase
	Water cost	Irrigation labor cost	Gross returns	Net returns	
					%
Irrigated corn	$6.20	$38.25	$85.15	$40.70	33
Non-irrigated corn	------	------	27.00	27.00	
Irrigated squash	2.15	11.60	144.00	130.25	32
Non-irrigated squash	------	------	88.00	88.00	
Irrigated beans	8.80	66.50	160.00	85.20	30
Non-irrigated beans	------	------	60.00	60.00	
Irrigated eggplant	14.30	36.00	160.00	109.70	18
Non-irrigated eggplant	------	------	90.00	90.00	

Separating prunes into quality grades. It has been found possible to separate both fresh and dried prunes into grades showing varying degrees of maturity and quality. The process used to separate the fruit is a flotation system employing heavy density sirups where dried prunes are to be separated. The application of this method to fresh fruit is more accurate and at the same time very inexpensive as the solution used is salt brine of varying densities, ranging from 30° to 60° Salometer.

This system can be used to determine the maturity of the fruit as well as actually separating the fruit into grades showing varying degrees of maturity. It is recommended to prune growers for the purpose of separating the green fruit from the ripe fruit before dehydrating. This separation will improve the quality of the resulting dried product, speed up drier operation and not increase cost of handling above that now obtained in the usual methods employed for dipping the fruit.

This process has been patented by Public Service Patent No. 1,728,583, as well as a machine which was designed for the separating process. This machine is covered in Public Service Patent No. 1,754,923.

Methods of bleaching cherries for maraschino. For many years Royal Ann cherries in the Northwest have been used primarily for canning. To some extent individual commercial concerns have used these cherries for maraschinos, but this process is not yet popular, probably due to lack of information concerning satisfactory methods of bleaching. There is also increased demand for cherries in brine by Eastern manufacturers of maraschino cherries. The increase in the tariff on this commodity is creating more interest in Western cherries, and will consequently influence to a great extent our markets for this particular commodity.

A satisfactory bleaching method was developed by the department last year. Details of this method are described in Circular of Information No. 30. Considerable study remains to be done, however, before every step in the production of maraschino cherries can be carried through with assurance.

Preservation of berries by the freezing method. This project has been carried on since March, 1929, and thus far more than 700 containers have been packed and checked.

Results of our investigations have shown that:

1. Improvement is necessary in the type of paper carton used for the purpose of freezing, as the present cartons are too absorptive.
2. Discoloration, due to exposure of the product to the air, is less pronounced when sirup instead of dry sugar, is added.
3. The keeping quality of the product after defrosting is also better when sirup is used instead of dry sugar.
4. Evidence of shrinkage is more pronounced in cartons packed with dry sugar than with sirups.
5. The retarding action of the cartons has some effect upon improving the quality of the finished product by permitting longer osmotic action before freezing actually sets in.

We have found that pronounced discoloration occurs only when the fruit is exposed directly to the air. If the sugar has completely coated the fruit, the discoloration is extremely slow. Delayed freezing has proved an advantage in that there has been a more prolonged interchange of the sugar with the fruit juices, which has had the effect of toughening the berry to withstand the defrosting operation.

DEPARTMENT OF POULTRY HUSBANDRY

Poultry production problems have increased with the large expansion of the commercial poultry enterprise. Basic facts relative to best methods of feeding, breeding, brooding, incubation, management and control of diseases are required. Important investigations are now being conducted, but additional investigations of outstanding problems should be made as rapidly as funds will permit.

Breeding to extend the profitable laying age of the domestic fowl. This project continues to constitute the major experimental work of the Poultry department. In this project an attempt is being made to breed strains of S. C. White Leghorns and Barred Plymouth Rocks wherein at least 50 percent of the individuals can be relied upon to produce profitably for four or more years. During the past two years added equipment has made it possible to consider the birds more by families instead of by individuals. In a long-time project of this nature it is always difficult to be sure that an apparent improvement in one generation over its predecessor will remain constant. Certain of the families with which work is being done are showing very promising results, which give every indication of constituting permanent advancement.

Some of the disease factors which caused considerable annoyance in the work during the preceding biennium seem to have been curbed considerably by changed and improved management practices, but it is still felt that disease constitutes a very important limiting factor.

Congenital Loco in chicks. Since about 1924 a peculiar type of cripple chick has been noticed in some of the Station hatches at hatching time.

Commencing in 1926 very careful pedigree records were kept on such chicks. At the conclusion of the hatching season of 1929 sufficient data were at hand to tabulate. These tabulations indicated that the condition, which had been named Congenital Loco, is heritable and that the mode of inheritance is probably that of a simple Mendelian recessive. The results of the tabulations made of these data were published as Station Bulletin 253, Congenital Loco in Chicks. An attempt is now being made to eliminate this factor from the Station stock by the application of breeding tests. The 1930 season produced no results not entirely consistent with the expected behavior of the factors as given in Bulletin 253.

Cost of producing commercial eggs in Oregon. The final year of field data in a three-year cost and efficiency survey of commercial poultry production conducted cooperatively by the departments of Poultry Husbandry and Farm Management was completed.

In addition to the regular Experiment Station projects it has been possible, through cooperation with and by using the stock and equipment of the resident instruction plant, to carry on additional experimental work.

Effect of feed on egg yolk color. Because of a growing demand for the light-colored egg yolk on Eastern egg markets, where a large percentage (of the surplus) of Oregon eggs is sold, the Oregon Poultrymen's Association requested information on methods of feeding that would meet these requirements. An experiment was carried out which showed that the amount of green feed fed was a controlling factor; that fowls fed an unlimited supply of green feed produced dark-colored egg yolks. By limiting the amount of kale to five pounds per 100 fowls, or, where alfalfa leaves and blossoms were used for green feed, to 5 percent of the egg mash, the pale yolk requirement was met with apparently no undesirable effect on health of fowls or on egg production.

Time of first feed for chicks. A general practice among poultry keepers has been to withhold feeding until baby chicks were 72 hours old. In order to obtain more definite information on this problem an experiment was started in March, 1930. It will be necessary to carry this work through another season before definite results can be published or recommendations made. The results so far indicate that chicks may be fed with good results at 24, 48, or 72 hours from time of hatching. Should further experiments which will be conducted confirm these results it will be of great help to hatcheries, which ship chicks long distances into other states.

Rearing and maintenance cost. During the biennium the department has continued its management cost studies started six years ago. Much information has been obtained on the cost of producing young stock and the cost of maintaining laying flocks. The results of these studies are furnished to poultry keepers and have proved of great value.

Hopper feeding and litter feeding of layers. An experiment was started in November, 1929, to check the feeding plan now being recommended by the colleges of the New England states, namely that all grain and mash be fed in hoppers in order that the layers can help themselves at all times. Two pens of Barred Plymouth Rock pullets were used in the experiment. One pen was hopper fed, the other was fed according to the

Oregon Station recommendation. The grain was fed in the litter morning and afternoon, and the mash was kept before the fowls in hoppers. The results of the first nine months show a profit of 12¢ per bird in favor of the litter-fed pen. It will be necessary to carry this experiment through another year and with additional flocks before definite conclusions can be drawn.

DEPARTMENT OF SOILS, IRRIGATION AND DRAINAGE

Research work in soils, including soil surveys, drainage, irrigation, soil fertility investigations, and all field and laboratory experiments of the Soils department at Corvallis are maintained under special biennial state appropriations of $10,000 per year. Approximately one-half of this fund is utilized in Federal cooperation project, $2,000 per year being devoted to the cooperative soil survey in agreement with the United States Bureau of Soils, and approximately $2,500 a year expended in cooperative irrigation and drainage investigations with the Federal Division of Agricultural Engineering. Of the remaining fund about $1,000 per year is required for publications and nearly $1,000 per year is used to maintain and supervise the alkali land reclamation experiment field near Vale, Oregon, which is the oldest experiment field of this kind in the Northwest. The residue of the funds is insufficient to meet the responsibilities of this department, resulting in meager, inadequate soil fertility trials. Although long time fertilizer trials should be conducted on the main soil types which have been mapped by the soil survey, inadequate funds seriously restrict such experiments. The expansion of the campus over land previously utilized for fertility and rotation trials has forced the shifting of these trials to new land, where they may be established on a permanent basis. There is a lack of funds, however, for adequately operating this new tract of land.

Investigations are correlated by a soil committee, including the soil bacteriologists and agricultural chemist.

Soil surveys. In cooperation with the United States Bureau of Chemistry and Soils approximately one-half the total tillable area of Oregon's agricultural land outside the National Forests has been covered by soil surveys, which include the classification and mapping of the different types of soil within each area. The reports issued describe the topography, climate, soil characteristics, physical and chemical composition, crop adaptation, and methods of utilization. The resources of the soil are appraised and information presented which will enable any farmer to determine the most desirable utilization of his land. The total area which has been thus surveyed is as follows:

Older Detailed Surveys—U. S. Bureau of Soils

Area	Acres	Year of survey
Baker	101,120	1903
Salem	181,824	1903
Marshfield	627,200	1909
Klamath	159,360	1909
Medford	348,160	1911
Hood River and White Salmon (Washington ½ Oregon ½)	72,000	1912
	1,489,664	

Cooperative Detailed Surveys—Oregon Experiment Station and U. S. Bureau of Soils

Area	Acres	Year of survey
Yamhill	458,960	1917
Washington	478,840	1919
Multnomah	288,640	1919
Josephine	1,120,640	1919
Benton	440,320	1920
Clackamas	1,192,960	1921
Polk	438,980	1922
Linn	1,022,252	1924
Lane	828,160	1925
Grand Ronde	250,000	1926
Marion	566,476	1926-27
Columbia	423,680	1928-29
Umatilla (started in 1929)		
Grand total	7,509,908	

Feasibility surveys. Feasibility and rehabilitation surveys cooperatively conducted by the Division of Agricultural Engineering, United States Department of Agriculture, and the Oregon Station have been made to aid irrigation and drainage projects in establishing the production value of the land and to assist in putting projects on an economic basis for development. During the biennium the following projects were surveyed.

Project	Acres	Construction cost
Owyhee	13,900	$18,500,000
Tumalo	15,154	650,000
Silver Lake	6,500	274,000
Summer Lake	4,941	325,300
Payette	5,600	262,000
Lone Pine	2,438	195,000
Hermiston, etc.	30,000	3,250,000
Scappoose	5,000	400,000
Total	83,533	$23,856,300

Reclamation. The problems of irrigation and drainage were studied cooperatively by the Federal Division of Agricultural Engineering and the Oregon Station.

In the Baker Valley, where a considerable area is affected by high water-table, studies were made of the effect of pumping water for drainage, and applying the water thus obtained for supplemental irrigation. The survey included a study of topography, ground-water conditions, well logs, amount and distribution of alkali, and the character and yield of crops in relation to alkali injury.

In the Coquille Valley the problem of flood control was studied by obtaining records of the run-off and the establishment of flood levels. The study included such points as the volume of water to be handled, height of dikes to control normal high water, and tide gate capacity to draw off water from the bottom-land. Also, the possibilities of channel improvement and supplemental pumping were considered.

Special study was given the seepage and drainage problem in the Rogue River Valley in a large area where the water-table is within five feet of the surface. Several hundred soil borings were made and tied in with a level net and the position of the water periodically determined. These borings have aided in determining the source of the excess water, and point to the necessity of the more efficient use of irrigation water so that the irrigation requirements may be reduced.

Cooperative ground-water surveys. Appraisals of the ground-water resources of the Willamette Valley have been made in studies conducted by a ground-water geologist of the U. S. Geological Survey cooperating with the Oregon Station. These studies are being continued in the Wasco and Harney valleys to determine the feasibility of obtaining water for irrigation through deep wells. In both the Wasco and Harney county districts financial assistance has been given by local chambers of commerce in conducting the study. Interest in well irrigation in the Harney Valley has been stimulated by the successful development of a well which produces 2 second-feet of water at the Harney Branch Experiment Station on an 80-acre demonstration unit under special legislative provision.

Well irrigation in the Willamette Valley. The feasibility of supplemental irrigation in the Willamette Valley by use of deep wells has been demonstrated by the installation of an 18-inch well, 155 feet deep, which has developed a flow under continuous pumping of 2 cubic feet per second or sufficient water to irrigate 160 to 200 acres of land. This experiment and demonstration were made possible through a revolving fund provided by interested business men and by an enterprising berry grower who had the courage to join in the work and agree to take over the well at replacement cost. This development is a result of the ground-water survey which determined areas in the Willamette Valley favorable for deep well irrigation. It is planned to install a second demonstration well providing irrigated pasture in connection with intensive dairying in one of the Willamette Valley areas.

Soil fertility investigations. Practical methods of building and maintaining soil fertility have been developed through experiments with fertilizers, lime, and rotations conducted simultaneously with soil surveys, field trials and fundamental laboratory studies cooperatively conducted by the soil workers, the Station chemist and the bacteriologist.

These soil investigations are conducted in five different fields on the college farm in addition to cooperative trials on fourteen different farms in different sections of the state and at four branch stations.

A few of the soil fertility and plant nutrition studies on which progress has been made are cited as illustrations.

Crop rotation. Experiments conducted show that crop rotation is of primary importance in continuing productiveness and maintaining soil fertility. Crop-rotation experiments to be most effective must cover long periods of years, but the expansion of the campus has compelled the discontinuation of the crop-rotation plots which have been conducted for 15 consecutive years. A new soil-building rotation trial has been developed for the new agronomy farm at Granger, where it will be made a permanent experiment covering a long period.

The accumulated results over the 15-year-rotation experiment show that the yield of beans under continuous cropping was reduced from 12 bushels per acre to an average of 6 bushels per acre, while the yield under rotation with manure and irrigation has increased to almost 30 bushels per acre.

Sulfur for alfalfa. Increasing the value of the state's alfalfa crop by approximately $400,000 per year is a notable accomplishment of the Oregon

Agricultural Experiment Station. This increase in value is credited to the Station because it discovered that the addition of sulfur to alfalfa increased the yield an average of one ton per acre. This fertilizer is now used on about 50,000 acres of alfalfa within the state, and its use is expanding rapidly.

During the biennium striking results have been obtained from the use of sulfur on river-bottom land with clover. Maximum seed yields and an increase of 1½ tons of hay per acre have been realized. Recent investigations show: (1) that sulfur often improves the reaction of arid soils for alfalfa nutrition; (2) that sulfur often provides a more favorable concentration of calcium for alfalfa nutrition; and (3) that under certain conditions sulfur overcomes the deficiency in sulfate concentration early in the growing season when it is most needed.

During the biennium studies of the rate of availability in the different forms of sulfur used as fertilizer have been conducted.

Lime is fundamental to the establishment of permanent agriculture in that most of the soils in the humid sections of Oregon are unfavorably acid for the best growth of soil building legume crops.

Recent investigations reveal the fact that legumes are heavy feeders on calcium, the essential nutrient in agricultural lime, and confirm the findings of the Station over a period of 15 years, indicating that lime is responsible for improving the physical condition of legumes, increasing the growth of nodules on the roots, and increasing the formation of available nitrate in the soil.

Phosphate. Recent experiments indicate that phosphate fertilizer used in combination with manure or decaying organic matter is very beneficial to "worn out" drained land in Western Oregon. Phosphate fertilizer applied to Chehalis loam soils has given earlier and heavier fruiting of strawberries and tomatoes. The best results have been obtained when the fertilizer has been applied in grooves a few inches below the surface rather than being thoroughly mixed with the soil, as there is a tendency for the phosphate to become precipitated and unavailable when so evenly distributed. Experiments show that phosphate has improved the rooting and prevented heaving or freezing out of young clover seedlings in Clackamas county.

Potassium. Extensive laboratory analyses in connection with greenhouse and field fertilizer trials during the biennium have shown that the peat soils of the state are usually low in potassium, both in total and water soluble form. The water-soluble potassium has been increased by applications of potassic salts, barnyard manure, or lime. These treatments increased both yield and quality of crops produced. The yield of mint oil has been greatly increased, and the yield and length of fiber flax straw greatly improved, where potassium fertilizer had been applied to muck soil. Potassium seems to play an important role in the formation of carbohydrates.

Nitrogen. Experiments indicate that nitrate is very effective in increasing grain and cover crop mixtures, especially in Western Oregon where the weather conditions cause considerable leaching out of available

nitrate. Sodium nitrate has been beneficial in starting legume cover-crops in orchards where such cover-crops are essential to satisfactory tree growth.

Barnyard manure. Investigations to determine the economic rate, time, and method of applying barnyard manure to obtain most economic results, conducted for the past nine years at the college farm, indicate that increased efficiency per unit of barnyard manure is obtained from moderate to light applications. Manure is an unbalanced fertilizer and pays better returns when reinforced with phosphate fertilizer.

The yield and size of fruit in the Rogue River Valley has been increased by the application of barnyard manure, together with bulky nitrogenous green manure, and deeper penetration of irrigation water has been obtained.

Drainage investigations. Efficient methods of drainage and improving wet soils have been developed by the Station, and during the biennium assistance has been given the Wapato Lake project, Coquille Valley, Scappoose Drainage District, and other community enterprises in designing satisfactory drainage systems. During the past fifteen years 335 miles of tile lines have been designed according to plans worked out by the Station, largely as extension work.

Drainage surveys show that the average cost of providing outlets for the large wet areas in the Willamette Valley is about $10 per acre, and the estimated increase in crop value is from $10 to $25 per acre on drained land. The soil surveys indicate that the Willamette Valley has approximately three-quarters of a million acres which can be improved by drainage, thus adding an immense increase to the productive value of these lands.

Alkali land reclamation. The alkali problem, constituting one of the most difficult soil problems in the West, is being dealt with on the oldest alkali experiment field in the Northwest, located at Vale. Many ideas of different methods of treating alkali soils have been tried out at this experiment field, and some of these methods have given promising results. Much of the white alkali has been eliminated, and from 50 percent to 85 percent of the black alkali has been removed from the first 20 inches of the soil. A 2-ton crop of rye has been grown, followed by a good crop of sweet clover for green manuring, and then alfalfa established and a yield of 4½ tons per acre obtained on land which was previously considered as barren waste. Several resistant forage crops have been introduced, including Ladino, strawberry, and sweet clover, slender alkali grass, blue-grass, and rye-grass.

Irrigation investigations. Studies of the value of supplemental irrigation on the main floor of the Willamette Valley started 20 years ago have been continued through the biennium. The studies indicate the increase in yield of crops where water is applied during the dry season as follows: Potatoes, 56 bushels, hay 2 tons, beets 5 tons, beans 5 bushels, kale or corn 3 tons, per acre. A report of these studies has been published in Station Bulletin 235.

During the biennium extended studies of supplemental irrigation have been conducted on river bottom-land in cooperation with several college departments. These studies include water variation trials and field

fertilizer tests, which indicate that heavier increases in yield are obtained from the river-bottom soils through irrigation that is obtained from the main Valley floor.

SPECIAL INVESTIGATIONS

Soil correction trials. Experiments have been continued for improving black sticky or Cove clay at Corvallis, and a special study has been made and a report submitted dealing with the characteristics of the colloidal or ultra-clay factions of typical heavy Willamette Valley soil profiles, including a study of chemical composition, colloid content, reaction, exchangeable bases, and flocculents.

Improvement in the absorptiveness of heavy adobe soils in the upper Rogue River Valley for irrigation water has been obtained with sweet clover, Hungarian vetch, barnyard manure, and deep tillage. Trenching in manure is at present under trial. Advisory correlation work has been done in cooperation with the branch experiment stations at Burns and Hermiston, where other experiments of a similar nature are conducted.

Irrigation and fertilization of pasture land. The need of green feed late in summer for finishing lambs or sustaining the milk flow of dairy animals has led to irrigation trials with pasture mixtures, including Ladino clover, in cooperation with the departments of Animal Husbandry and Dairy Husbandry. It appears that a depth of 20 to 30 inches of irrigation a season has been needed. The rotation grazing alternated with irrigation seems necessary to provide good pasture continuously. The growth is quickened in the spring and sustained through the season by chemical fertilization. Applications of nitrate have been especially effective in this regard.

In cooperative trials with county agents in the Coast section superphosphate has helped to establish a stand and good proportion of clover in pasture mixtures and to increase the nutrient value of the pasturage.

Further trials are needed to determine more definitely the most economic fertilization needed to obtain the highest yields of nutrients on irrigated pasture.

Fixation of nitrogen by legumes. A special laboratory study has been made during the biennium to determine the amount of nitrogen added to the soil from the growth of Austrian field peas when cut off and turned under for green manure with and without inoculation, and with and without fertilization. Soils from the Moro Branch Experiment Station and from the East College Farm have been employed. A gain of several hundred pounds an acre of nitrogen has been obtained with some of the most promising treatments. The field pea was chosen for this study because it is an annual crop and has proved to be the best legume for crop rotation at the Harney Branch Experiment Station.

Search for essential elements. During the biennium field trials have been made of numerous new fertilizer compounds that have appeared on

the market. Some of these fertilizers have given good results and others have not.

Each of the leading soil types of the state were included in a trial of fertilizers recommended for their manganese content. Increases in yield were obtained on certain muck and peat soils when this fertilizer was applied to tomatoes and field peas. There is also some evidence that a little zinc may be helpful under certain conditions. One or two parts per million of iodine increased the growth of head lettuce in water culture trials, while four parts per million was harmful. Several of these new fertilizers require further investigations.

Utilization of peat soils. Studies of the fertilizer needs of peat soils for special crops have been continued. Manure and potassium have proved desirable on all of the soils from the four types of peat recognized in the Northwest. Lime has been helpful on the acid peat of the Willamette Valley and Coast sections. These treatments have increased the potassium content of the soil solution, and the yield and quality of crops.

A cooperative study of bacterial activities shows a correlation with treatments that increase yields when judged by carbon dioxide evolved.

Nutrient requirements on fiber flax. The value of fiber flax increases greatly with length. Muck soils produce some of the best flax grown in Ireland, according to reports of experienced growers there. Excellent vegetative growth of flax is obtained on our muck soils, but the content of fiber is low. Potassium has been found strikingly to increase the yield of fiber formed by flax on muck soils. Potassium seems to be of first importance for increasing length, value, and quality of flax. Potassium applied in association with some nitrate has made it possible to produce, under controlled conditions, flax plants over four feet in length. Potassium seems to be especially important in the early part of the growth period. Very early shallow planting on well prepared clover sod land, with good moisture control and with a rotation of crops to maintain fertility and control weed growth seems important with this crop. Supplemental irrigation is very helpful in drier seasons.

Replaceable bases in Oregon soils. A large number of determinations of exchangeable bases have been made in connection with the study for the reasons of the decline in alfalfa yield, reported from different sections. A good supply of exchange calcium seems to be associated with response to sulfate fertilizers.

Longevity of sulfur oxidizing micro-organisms. A study has been made in cooperation with the department of Bacteriology to determine the length of life of sulfur oxidizing bacteria in inoculated sulfur. It appears that these organisms will live in the sulfur for a few months, and that the duration of life depends somewhat upon the presence of suitable food, moisture and temperature conditions.

Reclamation of black alkali with different forms of sulfur. A chemical study has been made of the rate of removal of water-soluble alkali from samples taken from the Vale plots periodically, and a further study has been made of the effect of the treatment upon the amount of exchange bases obtained. It appears that sulfur is the best single treatment, that lighter applications can be employed in conjunction with barnyard manure, and that the form of sulfur is not important after the first few months.

DEPARTMENT OF VETERINARY MEDICINE

Outstanding progress has been made in the studies of livestock diseases, particularly with the liver-fluke of sheep, the stick method of vaccination against chicken-pox, and the differentiation of species of coccidia. Following is a brief report of the projects undertaken during the biennium.

Infectious abortion or bangs disease. Studies of this disease, which is the most serious of the infectious diseases affecting livestock in the state, were continued during the biennium with special investigations upon field work in the establishment and maintenance of herds free from the disease. The conclusions of this work indicate: (1) Herds free from infectious abortion are more profitable because they produce more milk, they produce more living calves, and they have less garget. (2) The disease is not self-eliminating under usual dairy management conditions. (3) The agglutination test is a satisfactory method of diagnosis. (4) Reacting cows and heifers do not usually change to non-reactors. Reacting calves do change to negatives. (5) The only satisfactory methods of control have been based upon the principle of preventing exposure of susceptible cows and heifers to infected animals. (6) Dairymen have found it practicable to control and eradicate the disease through testing their herds and protecting the disease-free animals from exposure. (7) The time necessary to establish a clean herd from an infected one has varied from less than 12 months to 3 years. (8) Herds have been kept free from the disease through preventing any exposure. (9) The Oregon State Livestock Sanitary Board issues certificates of accreditation to infectious abortion-free herds which meet certain requirements.

Sterility in breeding cattle—

Sterility in bulls. Previously reported studies of genital organs of bulls revealed that adhesions between the testes and the scrotum are of very frequent occurrence. Agglutination tests of such bulls indicate that there is no relation between infection with *Brucella abortus* and the occurrence of such lesions.

Sterility in heifers and cows. Studies in the relation of retained placenta to subsequent sterility have been continued. Data indicate infectious abortion-free cows which retained the foetal membrane usually breed afterward provided they are treated properly.

Mastitis. During the past eight months of the biennium some studies with mastitis were begun. This disease seems to be increasing in frequency among Oregon dairy cattle. Studies to date have consisted in clinical observations of animals affected and bacteriological and epidemiological studies. The work has not progressed sufficiently to allow any conclusions to be drawn.

Salmon poisoning in dogs. Since practically all the fish of the salmon and trout family which originate from the streams of Western Oregon carry the parasites of salmon poisoning in sufficient numbers to cause a disease if they are eaten by susceptible dogs, this trouble is a real problem among the farm- and ranch-owned dogs in the western half of the state.

Studies of this disease during the biennium have added considerably to the facts previously established. It has been shown by experimental feedings that the bob cat, the house cat, the brown bear, and both the eastern raccoon and the Pacific racoon may act as carriers of the parasite, although they do not develop symptoms of the disease. With the addition of these hosts to the group previously reported—namely, the dog, the coyote, the silver black fox, blue fox, and the mink—it is established that at least one genus of each of the five families of terrestrial carnivorous animals occurring naturally in Oregon is a host of this parasite. In previous studies it was shown that the fresh-water snail, *Goniibasis plicifera var silicula* (Gould), is the molluscan host of the fluke causing salmon poisoning.

Liver flukes in sheep and goats. Studies of this important parasite have been continued. In these investigations it has been found: (1) Fluke ova hatched in varying lengths of time from 14 days to 13 months and 20 days. (2) Freezing killed embryonated ova but did not affect those not embryonated. (3) Miracidia lived as long as twenty-four hours after hatching. (4) Miracidia attacked four species of *Lymnaeae* and one of *Physa*. (5) *Lymnaeae* are widespread throughout Oregon, even at very high elevations. (6) Snails lived at 37° F. for a month without food when water was provided. (7) Cercariae are capable of living in snails and being discharged for more than six months from date of infestation. (8) Individual snails are capable of living with large numbers of cercariae in them, 580 having been discharged from one specimen. (9) Carbon tetrachloride in 1 c.c. doses destroyed mature and nearly mature flukes in livers of sheep and goats. (10) Snails were destroyed by use of copper sulfate broadcast on habitat. (11) The destruction of snails did not prevent their reappearance on the same pastures the following year. (12) Cost of application was $5.25 per acre. (13) Copper sulfate broadcast in twice the amount necessary to kill snails was not poisonous to sheep.

Coccidiosis investigations have been directed chiefly toward the determination of species and the problem of immunity.

This investigation has resulted in the recognition of six species of coccidia, two of which are new and for which the names *Eimeria praecox* and *Eimeria necatrix* are proposed. Five species have been produced in pure culture. These will be used in connection with future investigations in an effort to establish more specific methods of control which can be applied on the poultry farms throughout the state.

The average size of fifty oocysts of *E. praecox* was found to be 20.6 x 23.8 microns, or a shape index (width divided by length) of 0.87. The oocysts prove infective after twenty-four to thirty-six hours sporulation at room temperature. New oocysts appear in the feces on the fourth day after feeding sporulated oocysts, a few hours sooner than with *E. acervulina* (Tyzzer). *E. praecox* attacks the small intestine, beginning near the gizzard. Failure in cross-immunization has been established between *E. praecox, E. mitis* (Tyzzer), *E. acervulina* (Tyzzer), and *E. maxima* (Tyzzer).

E. necatrix attacks the small intestine, beginning near the gizzard, and in severe infections produces marked hemorrhages and dilation of the intestine. The schizonts are the largest of any species attacking the duodenum and free portion of the small intestine. The average size of nine schizonts selected from a large number was 49.2 x 63.1 microns, and included a minimum of 42.0 x 44.0 microns and a maximum of 62.7 x 84.7 microns.

The results of the coccidiosis investigations for this biennium will be read at the 1930 meeting of the American Veterinary Medical Association and will be published during the coming year.

Fowl-pox investigations begun during the biennium 1924-1926 have been continued. This has resulted in the development of the stick method of vaccination, which has proved highly successful in preventing one of the outstanding diseases encountered by the specialized poultryman.

The stick method of vaccination was recommended to the poultry industry during 1929. That it has met with a good response is evidenced by the fact that more than 92,000 fowls were vaccinated by this method in this state during the summer and fall of 1929. It is anticipated that there will be 100,000 fowls in this state vaccinated by this method during the summer and fall of 1930.

Pullorum-disease investigations involved a cooperative agglutination-test project and study of an unusual manifestation of the disease in chicks.

The cooperative project has been conducted jointly with the University of British Columbia, Department of Poultry Husbandry, and the Western Washington Experiment Station, Department of Veterinary Medicine. A paper, "Accuracy of the Agglutination Test in Determining Pullorum Carriers," reporting the results of this investigation will be read at the 1930 meeting of the American Veterinary Medical Association and will be published.

Investigation of an unusual condition found recently in young chicks and accompanied by enlargement of the joints and lameness has been established as one of the manifestations of pullorum disease.

MISCELLANEOUS INVESTIGATIONS

Tapeworm. No information has been available as to the efficacy of widely used tapeworm remedies for the control of a tapeworm (*Davainea proglottina*) which is very common throughout the state. Opportunity was afforded during the past biennium to test the value of powdered kamala and a colloidal iodine preparation against this tapeworm. The results emphasized the importance of controlling the problem by sanitation in preference to treatment with these drugs.

Blackhead. This disease has been found for the first time in this state in the pea fowl. Attempts to control blackhead by cecal abligation have resulted in such a high percentage mortality as to make the use of this method inadvisable.

Salamander poisoning. The feeding of salamanders to mature chickens has been found to prove fatal in some instances and relatively harmless in others. Since salamanders are common throughout the western part of the state the advisability of attempting to exclude them from the areas to which fowls have access is apparent.

Lung worm in sheep and goats. Experiments with these parasites have been restricted almost entirely to attempts at finding some satisfactory medical treatment. Two types of tests have been made. Several of the substances tested destroyed lung worms in vitro, but none were satisfactory when used in vivo.

The so-called Sherman county disease. An undiagnosed malady of sheep and horses in Sherman and adjacent counties was studied. The causal agent was not discovered but all experiments indicated it was associated with grazing on native pastures. Further studies are being conducted.

Pregnant ewe disease. This disease has been reported during the biennium from every part of the state where sheep are raised in considerable numbers. It usually appears within the last 15 days of pregnancy and shows a marked tendency to attack those ewes which are carrying twin lambs. Most of the cases which have been observed have been in rather good physical condition but a few have been quite thin. There is no evidence that the diet has any direct influence on the appearance of this trouble other than its relation to the general condition of the animal. Work on this project is being continued.

Meat identification. During the biennium requests reached the laboratory for help in identifying some of the meats which were being marketed in the state as sausage. It has been definitely established by several investigators that meat can be identified through precipitin tests.

White muscles in lambs. For several years lambs have been brought to the laboratory for diagnosis which upon autopsy revealed a whitish color of some of the muscles of the body. The clinical histories of such cases indicate that the lambs have been well fed and have developed quite rapidly. In a chemical analysis of these white muscles it was found that approximately .9 percent calcium was in the affected muscles, while normal muscles on the same animal carried .12 percent calcium. No cause could be found for the deposition of the calcium in these muscles.

White scours in calves. A rather serious outbreak of this trouble in which approximately 30 percent of the calves born in a herd of some 60 breeding animals were lost from either scours or pneumonia was observed during the biennium. One of the commercial calf-scour sera was tried both as a preventive and as a curative agent. While results from treatment were quite unsatisfactory, there was some encouragement from the use of this serum as a preventive.

Lip and leg ulceration in sheep. This disease continued to appear in practically every section of the state. The losses are heaviest among young lambs. A single attempt was made to vaccinate against this trouble through the introduction of virus from a naturally affected anmal into the skin of the inside of the thigh of a susceptible animal.

Stomach worms (*Ostercagia circumcincta*). This is a most common stomach worm found in Oregon sheep and goats. Infestation may occur at any season of the year. Treatment with tetrachlorethylene stopped death losses from this disease.

Parasitic infestation of lambs on irrigated pastures. A group of lambs on an irrigated pasture in Western Oregon was studied with special attention to parasitic infestation. Lambs were turned on this pasture following a period of pasturing by mature sheep. Within three weeks scours had appeared and the lambs showed indication of parasitic infection. Autopsies resulted in finding encysted stomach worms and inflamed mucous membranes. Further observations are under way.

PROGRESS AND RESULTS OF INVESTIGATIONS AT THE BRANCH EXPERIMENT STATIONS

AT THE experiment stations at Astoria, Burns, Hermiston, Hood River, Moro, Pendleton, Talent, and Union investigational work has been centered as in previous years primarily on the major agricultural problems of the respective agricultural section represented by the branch station. In addition the branch stations have cooperated with the Home Station at Corvallis in investigations for solution of problems common to larger sections of the state or the state as a whole. The character of work and the results at the several stations are stated briefly in the following pages.

JOHN JACOB ASTOR BRANCH STATION, ASTORIA

The work of the Astoria Branch Station has made satisfactory progress during the biennium, the major projects being devoted to forage crops, soil fertility, and dairying. Results with projects of this type require years of time and patient effort, and the results for a single biennium can merely indicate progress in reaching the ultimate solution of these problems.

Soil fertility. Fertility trials run for thirteen years show conclusively that lime, superphosphate and manure are of value to Clatsop county farmers in the production of forage crops for the dairy herd. Definite conclusions drawn from these tests are:

1. Lime is essential to maintain the fertility of the Coast soils.

2. After the original fertility is depleted lime is more essential than manure in building up the soil.

3. Legumes cannot be grown without lime after the original fertility has been depleted. A good stand of legumes cannot be secured or maintained by the application of liberal quantities of manure only.

4. Manure has its greatest value in increasing production of crops, but lime is necessary to obtain a satisfactory stand.

5. Superphosphate is highly profitable when applied to root crops.

Legumes. Tests with legume crops which are essential to economical dairy production indicate that the Austrian Winter pea is especially valuable. This legume is adapted for hay, silage, and green feed. Sixty pounds of seed per acre is sufficient to obtain a good stand. This legume yields from three to five tons of hay per acre. Variety trials of other legumes will be continued in the next biennium.

Although the Coast section usually has mild winters, some winter killing of annual legumes has occurred. Results at this Station indicate that both manure and lime decreased the amount of winter killing. The severe winter of 1929 killed all of the plots which were not manured or limed.

Root crops. Variety trials of root crops conducted at the Station indicate that the turnip is proving the most satisfactory type for the Coast section. This crop does well on land of medium fertility, producing heavier than other root crops. Land capable of producing 25 tons of mangels per acre will produce approximately 33 tons of rutabagas or approximately 40 tons of turnips per acre. The outstanding variety Bortfeld was introduced in 1929.

Experiments with root-maggot control indicate that the time of planting is the determining factor in the amount of injury from this insect. The experiments indicate that the Bortfeld turnip is very resistant to attacks from the root-maggot.

All varieties of rutabagas are susceptible to aphis, but the turnip appears to be resistant.

Contagious abortion control. In this project, started in 1921, the Station has been successful in eradicating contagious abortion, and in maintaining a clean herd by semi-annual tests and good sanitation. At the present time the Station herd is entitled to be an accredited abortion-free herd.

Investigation of oat rust. In the tests for oat rust which has in some years caused the complete loss of the oat crop in the Coast sections rust nurseries have been mainained for three years in cooperation with the Central Station and the United States Department of Agriculture. To date three varieties have given promise of being resistant to this disease. Further tests will be made with these varieties.

Balanced dairy rations. Two dairy rations have been tested and recommended at the Station for feeding under Coast conditions. As a result of these tests more than 2,500 tons of rations as recommended by the Station were mixed and sold by one feed organization in the Coast section.

Soiling crops. The practice of feeding soiling crops in the Coast section is becoming widely established. To develop the best crops for this purpose, the Station has undertaken experiments to test various crops for their green feed value. Mixed clover and grasses are now being tested to develop green feed which may replace the Japanese millet now recommended in the system of management. The grass and clover is obtained by cutting the first crop early in June so as to have a satisfactory second crop during August. The results so far obtained have been satisfactory.

HARNEY COUNTY BRANCH STATION, BURNS

Investigations with cereals, forage and root crops on dry and irrigated land were continued during the biennium. These experiments require years of time and patient effort to present definite results. Satisfactory progress is being made from year to year and outstanding results have been obtained from the new irrigation unit which was started in 1926. The statements following indicate the facts of value as a result of investigations at this Station.

Irrigation with pumped water. The successful production of crops under irrigation by the use of water from a well 85 feet deep, financed in 1926 through a special legislative appropriation, was accomplished during the biennium. This is of particular importance to farmers in the district inasmuch as thousands of acres of good land in the Harney Valley cannot be irrigated except through the use of deep wells. The only method of reclamation would be by pumping. The successful production of crops during the biennium has created a keen interest in pump irrigation and ten farmers in the district have drilled wells and tested them for capacity.

Varietal experiments on dry land. The uncertainty of maturing satisfactory crops in dry-farming operations where the 15-year annual average precipitation totals but 8⅓ inches, indicates the importance of determining drouth-resistant varieties. The Station has found that Baart is the leading variety of spring wheat and Hard Federation shows promise as a beardless variety. Hannchen barley, Sixty Day and Silver Mine oats and Verne spring rye and Grimm alfalfa are the best varieties for dry-land farming.

Varietal trials for irrigation. Further investigations during the biennium indicate that the following crops continue to be the leading varieties under irrigation: Turkey and Turkey hybrid No. 63 winter wheat; Trebi, O. A. C. No. 7, and Hannchen spring barley; Markton, Three Grain, and Western Wonder oats; Grimm alfalfa; Canadian field peas; Mammoth Russian sunflowers and Early Ohio potatoes. Federation spring wheat leads all varieties.

Rotation experiments. The rotation experiments are being continued. Field peas lead in the short rotation and Grimm alfalfa in the long rotation. The field pea breaks down readily and incorporates in the soil more easily than any other legume.

Fertilizer experiments. Fertilizer experiments started in 1919 have been continued and indicate that barnyard manure and manure reinforced with superphosphate lead in the economic production of crops.

Duty-of-water experiments. The duty-of-water experiments, started in 1921, have been completed for the heavy soil types on the Station. The results obtained indicate that the following amounts of water are the most profitable under normal conditions in the Harney Valley: Cereals 12 to 14 acre-inches; alfalfa, clover and field peas, 15 to 18 acre-inches; sunflowers about 30 acre-inches; potatoes 10 to 14 acre-inches. In years of extreme drouth these figures should be increased about 25 percent.

Cost-of-production experiments. The cost-of-production investigations started in 1927 were the major experiments conducted on the Station during the biennium. Detailed reports on the cost of producing the following crops under field conditions with pumped water from deep wells, will be available in 1931: Federation wheat, Canadian field peas and wheat combinations, Grimm alfalfa, and Early Ohio potatoes.

Varieties introduced, increased, and distributed. During its existence the Station has been instrumental in the introduction of the following varieties that have practically replaced all other varieties grown: Grimm alfalfa, Federation wheat, Trebi and Hannchen barley, Harkin oats, and Early Ohio potatoes.

UMATILLA BRANCH EXPERIMENT STATION, HERMISTON

The Umatilla Branch Station is jointly maintained by the Oregon Agricultural Experiment Station and the United States Department of Agriculture for the purpose of investigating problems related to establishing and maintaining permanent agriculture on sandy soils under irrigation. A brief report of the investigations undertaken follows.

Artichokes. Much interest has been developed in the growing of artichokes for the production of sugar, especially levulose, and for medicinal purposes. Extensive tests of growing artichokes were conducted during the biennium, including tests of time of planting, size of seed piece, fertilizers, time of digging, and the methods of planting.

The average yield was 20,150 pounds of tubers per acre. The chief problem in growing artichokes appears to be that of harvesting, since there is an enormous number of tubers. Improved methods of harvesting must be worked out to make artichoke production a profitable crop.

"Curly top" of vegetables. The "curly top" disease of vegetables has caused serious losses in sections where commercial vegetable production is conducted. The main hope for relief from this disease appears to be in finding resistant strains. To this end the Station has tested 843 different varieties of vegetables in an effort to select varieties most resistant to the disease. During the biennium one bean variety and one squash variety have been found to be resistant, and further tests will be made with these varieties.

Sweet clover. Variety tests of sweet clover are being made in an effort to develop a hardy type which can be used to replace the shallow-rooted clovers used locally for pastures. Some difficulty is experienced in obtaining stands of the shallow-rooted clovers which do not make practical pastures on account of the low water-holding capacity of light, sandy soils.

Reestablishing alfalfa. The reseeding of worn-out alfalfa stands presents a serious problem in the district. The yield of hay from old alfalfa fields has steadily decreased and the stands become thinner due to winter killing, the encroachment of weeds, and continuous cropping. It is difficult to obtain a good stand of alfalfa on the old fields. Investigations are under way to determine causes for difficulty in obtaining stands and to develop the best method for seeding alfalfa on such land.

Root crops. Tests are being made on root crops in an effort to develop succulent feed for dairy cows. The tests indicate that sugar beets, carrots, squash, and Jerusalem artichokes offer the best possibilities, the beets yielding 11,960 pounds, the squash 49,000 pounds, and artichokes 20,150 pounds per acre in 1929. Further investigations regarding the feeding value and the best methods of producing these crops should be conducted.

Value of manure. The oldest continuous experiment on the Station is that of the value of manure applied to alfalfa. This test indicates quite definitely that manure applied at the rate of 8 tons per acre is more valuable and effective than that applied at 32 tons, and indicates that the value of manure is not leached out rapidly but is available over a period of years. Each ton of manure applied at the rate of 8 tons per acre gave a return of 831 pounds of alfalfa, and at the rate of 32 tons the increase in hay was 369 pounds per acre.

Time of cutting alfalfa. The results of tests of time of cutting alfalfa hay show that the longer the alfalfa is allowed to grow the larger the annual yield, but the quality of hay deteriorates with the longer period of growth. These tests are being continued.

Cutting at the bud stage and at the 10 percent blossom stage has rather seriously reduced the stand of alfalfa.

Time of seeding alfalfa. Results of test of time of seeding alfalfa show that the best stands were obtained by planting early in March. Plantings were made at one-week intervals from February 15 to March 29. Early in March the winter moisture is still available and the plants have an opportunity to become well established before hot weather sets in.

Turkey investigations. Turkey production problems have increased in Eastern Oregon as the turkey enterprise has been expanded. To cope with these problems the Station has established a turkey unit and investigations are being made covering diseases through sanitation, economical production, and cost of maintaining the turkey flock.

Establishing dairy unit. The economical feeding of dairy cattle has developed to be an important problem locally, inasmuch as the dairy enterprise is expanding rapidly in the district. As a preliminary step in establishing dairy investigations, the Station has acquired 15 head of grade Jersey heifers and growing costs are being maintained. When these heifers reach breeding age, investigations will be made in regard to economical limits of supplemental concentrates feeding, and the comparative value of chopping and grinding alfalfa hay for dairy cows.

Alfalfa varieties. Thirteen outstanding varieties of alfalfa are being grown to determine yields and hardiness. Forty varieties recently obtained from Europe are also being tested at the Station.

HOOD RIVER BRANCH STATION, HOOD RIVER

Perennial canker and woolly aphis investigations. Observations made during the past two years further substantiate the fact that the woolly apple aphis is definitely associated with the advance of fully 90 percent of

perennial canker infection on apple trees in the Hood River Valley. Pruning during mid-winter or injuries occurring on the trees at times when no callus formation is taking place will permit infection. With proper orchard management this type of infection is of minor importance. Investigations at the present time are being directed towards the control of the aphis as a means of controlling canker. Positive results in the control of the disease are being obtained, both experimentally and in a practical way through the use of surgery, painting, and spraying for the insect involved.

From the standpoint of control, the most important finding of the biennium is the fact that nicotine slufate added to paints at the rate of one part of nicotine sulfate to four and six parts of paints used gave complete aphis protection throughout the season. Paints tested were various combinations of tanglefoot, diluted with equal parts of gasoline and carbon tetrachloride to a point where the material could be applied with a brush, and the Hood River tree paint, a rosin–fish oil–bordeaux combination. Where these combinations were used without the nicotine, noticeable aphis infestation developed late in the season. A complete life-history study of the woolly aphis is being made.

Introduction and investigation of the woolly aphis parasite, *Aphelinus mali.* Due to the fact that woolly aphis control appears to be the key to successful perennial canker suppression in this district, all possible means for prevention of aphis attack are being studied. This investigation includes the introduction and life-history study of the internal parasite of the woolly aphis, *Aphelinus mali.* A survey of apple districts of the Pacific Coast, made during the years 1926 to 1930, indicates that the parasite is nonexistent in this area with the exception that some were found in the vicinity of Vancouver, B. C., the apparent result of liberations made in 1922. The parasite was the first introduced into the Hood River Valley in the fall of 1928 from material gathered at Fenville, Michigan. The insects have successfully survived two winters in the field and have spread rapidly from points of liberation. Colonies have built up to the point where it has been possible to make liberations in a number of orchards of the district. General liberation will be made as rapidly as material becomes available. It is still too early to predict to what extent the parasite will influence aphis control but results thus far obtained are extremely encouraging. A complete ecological study of the relation of the parasite to the woolly aphis is being made.

Codling-moth and summer oil spray investigations. The economic importance of codling-moth control makes it necessary that life-history studies and spraying tests be continued. At the present time a large series of summer oils are being tested in various combinations and at different periods to determine, primarily, the limits to which oils of various viscosities may be used on Newtown apple, a variety highly susceptible to oil injury. Up to the present time observations indicate that oils with a viscosity range of 65° to 75° F. can be used in the first two cover sprays without causing injury of importance. This usage is further complicated, however, due to the fact that sulfur sprays are needed at times for scab and mildew control. From the standpoint of safety to fruit and foliage the period of time that must elapse between sprays containing oil and sulfur has not been definitely determined. It appears very questionable whether oils should be used in the early sprays where a fungicide is needed unless

an emergency occurs, such as the occurrence of a serious red spider outbreak.

Thrips control studies. Investigations dealing with the life-history and control of two species of thrips, *Frankliniella occidentalis* and *Aeolothrips fasciatus* have been continued during the biennium. During the past year thrips populations and damage to fruit were materially reduced through the use of nicotine sulfate employed at a time when approximately 50 percent of the blossoms were open. Oil sprays were found less effective. The insects develop in large numbers each year where they may be found feeding in the flowers of practically all of the native vegetation. These insects overwinter in the soil and it appears at the present time that during years when the soil temperature lags behind the air temperatures general emergence is too late for them to cause much damage to the apples which have been brought into bloom due to relatively warmer air temperatures. A study of the relation of soil temperature to air temperature and their interrelating effect as insect emergence and bloom period of apple has been started. This information will be used as a basis for making spray recommendations in controlling the pests.

Control studies of apple and pear scab. The adaptibility and compatibility of new insecticides and fungicides to established standard spray schedules make testing of spray combinations an endless procedure if growers are to keep posted on possible influences of these materials. The general adoption of spring and summer oil sprays in many sections makes it necessary that much investigational work be done to formulate a successful and safe schedule where these scab diseases are present. Susceptibility to spray injury varies with the different varieties of fruit. The Anjou pear is particularly prone to russet and at the present time shows some damage from supposedly safe combinations such as the Dry Mix sulfur and arsenate of lead. This appears in the form of a web-like russeting and is particularly noticeable on fruits in the lower parts of trees. Scab diseases are definitely sporadic in their occurrence in this district and as a result field tests covering periods of years are required to gather satisfactory information.

Strawberry root-weevil control. Tests have been concluded during the biennium dealing with the control of the strawberry root-weevil, *Otiohynchus ovatus*. Two well-timed applications of poisoned apple bait have been found to be completely successful. The first application, for the purpose of destroying overwintering beetles, should be made at a time when the plants begin to show numerous blossoms, and the second should be made shortly after harvest has started. An examination of the adult beetles for mature eggs is a good index for the timing of the application. As the season for baiting approaches, beetles should be gathered from time to time and placed in closed jars. Small pearl-white eggs will be found in these jars as soon as egg laying is ready to occur in the field. This observation can be used in conjunction with fruit development for the correct timing of the poison. A dessert spoonful of the bait should be well placed in the crown of each plant. Thorough work is the key to successful control. This can be either applied by hand or with an elongated funnel through which the bait is applied to the crown of the plant. Experience has shown that border baiting can not always be relied upon to give good control in areas where

the pest is troublesome. Young plants should receive at least one application, preferably the summer baiting.

The hardiness problem, tree fruits. Extremely low winter temperatures in 1919, 1924 and 1926 were the direct cause of widespread death or serious injury to apple, pear, cherry and other fruit trees in the Mid-Columbia section. The greatest mortality followed a temperature of -26° F. in December, 1919. Previous reports indicated the character of injury sustained and the accompanying susceptibility of certain varieties such as Newtown to attacks of perennial canker.

February, 1929, and January, 1930, were characterized by minimum temperatures of -11° and -19.5° F. During both winters pear trees, especially Bartlett, were susceptible to a sunscald type of freezing injury on the south side of tree trunks. Studies were continued to determine the extent of freezing injury in pears where growing on *Pyrus communis* and *Pyrus serotina* roots. The record over a period of years favors *communis*. Twelve and one-half percent of two-year-old Anjou, Bartlett and Bosc on *serotina* roots in 1925 and 7.5 percent of three-year-old in 1926 were completely girdled by freezing injury in addition to extensive trunk injury on remaining trees. The average total mortality in three- and four-year-old trees of similar varieties on *communis* root in 1929 and 1930 was only 3.1 and 0 percent. Pear trees six and seven years old were more resistant to winter extremes than those one and two years old.

A comparison of the extent of freezing injury on nine varieties of one-year-old pear trees was made following the winter of 1928-29. Although all varieties without exception exhibited varying degrees of injury those on *serotina* showed a much greater total mortality or injury than those on *communis*.

The complete killing in trunks (involving complete girdling of cambium) on *communis* and *serotina* was 6.1 and 28.6 percent respectively.

Comparison was made in seven-year Anjou, Bosc, and Bartlett on the extent and character of freezing injury where grown in alfalfa (with cultural strips) or intercropped with strawberries. A careful check on the character and extent of winter killing in the two blocks shows no significant difference.

Trunk protection studies. Studies were continued bearing upon the value of whitewashing and shading tree trunks in reducing winter injury in this area. During the 1928-29 winter six-year-old Bartlett, Bosc, and Anjou trees were treated in this manner. Seventy-nine percent of unprotected trees sustained slight to severe trunk injury which was principally a "sunscald" type. Where trees were shaded with boards or with whitewash, only twenty-two percent of trunks showed injury.

During the 1929-30 winter the experiment was continued and enlarged. Certain brands of whitewash were found less adhesive than others. Paints smoothly applied to dry bark surfaces adhere best. Applications made during wet, frosty weather were less adhesive. Preliminary observations indicate that spraying these materials on trunks is a satisfactory method.

Orchard fertility investigations. A seven-year summary of average yields per tree from a full bearing Anjou orchard on a light Upper Valley loam was made. The trees are set twenty feet hexagonal, and, being very

large, a crowded condition resulted. Nine plots were maintained on which the amount and source of nitrogen, spring applied, varied, being derived from nitrate of soda, sulfate of ammonia, blood, and Ammo-Phos. Sulfate of potash was used in some plots and superphosphate in others. "Complete" mixtures and sheep manure were also applied. Yields varied from 6.95 to 9.12 boxes per tree. No significant results have been obtained up to the present time. Phosphorus is definitely improving cover-crop growth. Cover-crops in plots where this element was applied in combination with nitrogen are outstanding in comparison with the poorer growth where nitrate of soda or sulfate of ammonia alone was applied. The value of nitrogen in promoting tree growth is also indicated. Future tests in this orchard are to be based on spring and fall applications.

The program bearing upon the value of cover-crops and fertilizations was continued and enlarged, both in Station and cooperative bearing orchards. All of the new experiments are designed to test the value of potash and phosphoric acid in combination with a quickly available nitrogen fertilizer, such as sulfate of ammonia or nitrate of soda.

The department of Agricultural Chemistry is making soils analyses to determine the amount of nitrate nitrogen in soils where sweet clover is growing or has been turned under. Green weights of sweet clover tops and roots to a depth of two feet were taken. The average number of plants per square yard was 110 and the acre weight of roots (which were heavily noduled) was 12,161 pounds and that of tops 37,647 pounds.

Average yields per tree for a seven-year period were summarized in a 27-year-old Newtown orchard located on a well-drained Hood silt soil. Trees in Plot 1 received an annual early spring application of six pounds of nitrate of soda. Plots 2, 3, and 4 received respectively 5 pounds sulfate of ammonia, 16 pounds 6-10-4 mixed fertilizer and 21 pounds dried ground sheep manure. Average yields for the entire period are practically identical being 12.2, 12.3, 12.0, and 12.1 boxes per tree. The unfertilized plot averaged 10.1 boxes. Fertilizers in this orchard have not overcome the alternate bearing habit, which was pronounced in 1927 and 1929.

Soil management. Studies are to be made under commercial growing conditions. This is a new project and an effort will be made to correlate over a period of years such practices as irrigation, cover-crops, and fertilizers with yields, grades, and quantity of apples.

Strawberry fertilizer. The effectiveness of the use of commercial fertilizers in conjunction with sheep manure was demonstrated with Clark Seedlings on Parkdale loam in the 1928, 1929, and 1930 seasons. Applications of sheep manure made with the commercial fertilizers increased their effectiveness in all cases.

Alfalfa fertilizers. On Parkdale loam some growers are experiencing difficulty in obtaining a normal stand of alfalfa. The soil is low in available calcium, sulfur, and nitrogen. New land is also deficient in humus. The following fertilizers were applied in the spring of 1930: sulfur, land-plaster, superphosphate, muriate and sulfate of potash, Ammo-Phos and Nitrophoska. To date results of these tests are not outstanding. The tests will be continued.

Potato fertilizers. Three fertilizer experiments with Russett Burbank are in progress on Parkdale loam. "Complete" fertilizers derived from Ureau, treble acid, phosphate and muriate of potash are being compared with others derived from sulfate of ammonia, superphosphate, and sulfate of potash. The purpose of these tests is to determine the value of sulfur and potash in combination with nitrogen and phosphoric acid.

Tests in 1929 indicated that Nitrophoska (15-30-15) is a very satisfactory fertilizer for this variety. Yields were larger and grades better on plots where this fertilizer was used than on others where sulfate of ammonia and superphosphate without potash were employed.

Pruning investigations. Cooperative studies were made of individual limbs of full bearing Newtown apple trees during a four-year period. The character and distribution of different types of annual growth and the percentage of bloom were observed and charted.

Heavy thinning and thinning and heading were associated with the experimental pruning. Nitrate of soda and sulfate of ammonia were used at the rate of three to six pounds per tree in these tests.

An irregular growth and fruiting response followed the different methods employed. Heavy annual pruning resulted in increased terminal growth but the fruiting area was decreased. In some limbs the percentage of annual bloom showed moderate variation from the four-year mean; in others the variation was wide. Regularity of fruiting was not consistently improved.

VARIETY TESTING

Strawberries. The search for a variety which possesses greater commercial possibilities than Clark was continued. The need for so doing is emphasized in that Clark is susceptible to certain Rhizoctonia diseases that have greatly reduced yields and quality. Ninety varieties or strains propagated by the United States Department of Agriculture were fruited. A large number of new varieties received in 1928 from the Oregon Station were tested. Cannery tests in 1927 and 1928 indicate that crosses between Howard 17 and Klondike, also 542 mixed crosses, are meritorious. Similar tests in 1929 also indicate that O. S. C. No. 53 is valuable for this purpose. Fruit of this variety although somewhat small, is very attractive, being dark red and glossy. The flesh is dark red with solid core. The flavor is subacid. Canned fruit of this variety, packed as "Fancy" with 60 percent sugar, was adjudged high in quality by several experienced canners. Howard 25 and Klondike No. 108 also possess considerable canning merit. Oelrich's Improved Clark, a chance seedling of Clark, shows definite promise. The variety is a heavier producer and appears to be less subject to disease than Clark. This variety is being tested in both the Upper and Lower Hood River Valley.

Apples and pears. A red strain of Spitzenburg received from the Southern Oregon Experiment Station in 1926 is now fruiting. The fruit closely resembles Spitzenburg possessing a darker and more attractive red color. The flavor is slightly more subacid, the keeping quality excel-

lent. The Goodenough Spitzenburg (another red strain of local origin) is also in production. The fruit appears quite similar to the other type.

Observations were made on the development of color of Starking Delicious and Richared. On September 1, 1929, Starking possessed much deeper color than Richared. On September 28, this difference was relatively less but Starking still possessed deeper color. Keeping quality of both varieties under cold storage was similar.

Three russet types of Bosc are under observation. These are top-worked on Bosc to afford close comparisons. Only a few fruits of these strains have been produced up to the present time. These specimens have been freer of a certain unidentified blotch that very often appears on Bosc and greatly reduces its market value.

The Gorham pear was tested in the Station Orchard. The fruit, which closely resembles Bartlett in flavor, attained picking maturity September 13. Under cold storage or common storage conditions the fruit possesses good keeping and eating quality. Several of the other pear varieties under test have not yet produced fruit in sufficient quantity to judge their value.

SHERMAN BRANCH STATION, MORO

In cooperation with the Office of Cereal Crops and Diseases of the United States Department of Agriculture the following lines of investigations have been continued at this Station: (1) Varietal and rate-and-date of sowing experiments with wheat, barley, oats, peas, corn, alfalfa, and potatoes, (2) cereal breeding investigations, (3) tillage experiments, (4) fertilizer and crop-residue experiments, and (5) crop-rotation experiments.

Varietal experiments. Emphasis is being continued on the testing and improvement of wheat varieties. Extensive experiments are being carried on in nursery rows and field plots at Moro and at outlying nurseries in all the Columbia Basin counties.

Federation wheat, introduced, tested, and first distributed by the Moro Station, is now the leading wheat variety in Eastern Oregon. When improved for winter hardiness, this variety will be still more valuable. Two new varieties, hybrids between Federation and hardy winter wheats, are now in farm trials. These wheats are more resistant to cold than Federation and seem also to have the other desirable qualities of that variety—short and stiff straw, earliness, and productiveness.

Two pure lines from Fortyfold have been distributed to farmers in sections where Fortyfold is commercially grown. These pure lines differ from Fortyfold in having shorter straw and more resistance to shattering. At Moro, both pure lines have outyielded Fortyfold by more than 25 percent. Of the older varieties, Hybrid 128 has produced the highest average yield for a twelve-year period.

Cereal-breeding investigations. Improvement work with cereals includes pure-line selection and hybridization to increase yield, improve quality, and increase resistance to smut. As reported previously, several specialized strains or physiologic forms of stinking smut have been found in the Northwest, and the breeding work for smut-resistance has now entered

a new phase—that of determining the behavior of these specialized strains on resistant wheats and the making of new hybrid combinations to produce desirable varieties resistant to most or all forms of smut.

Several new early-maturing winter wheats which have shown promise in nursery trials have been advanced to field plot trials. An early-maturing wheat with enough hardiness safely to sow in the fall in the Columbia Basin, will increase yields and reduce hazards from drought.

Crop residue experiments. The disposition of the heavy wheat stubble left by the combine has been a source of much concern to the Eastern Oregon wheat grower. Most farmers have burned off this stubble year after year. The results of an experiment, started in 1923, to ascertain the effect on wheat yields of burning the stubble or of turning it under, show that the turning under of as much as two tons per acre of straw and stubble has resulted, during the seven-year period, in slightly higher average yields of wheat than have been obtained where the stubble has been burned. The addition of this organic matter doubtless will aid in maintaining better tilth and in checking erosion. While farmers have always been advised to turn under stubble rather than burn it, figures on actual yields from land with stubble burned and with stubble turned under for a long period of years have not been available. The results for the past seven years at the Moro Station show that the turning under of the wheat stubble is a good farm practice.

Fertilizer experiments. Five year's results in experiments with commercial fertilizers show that the average Columbia Basin wheat land, if properly handled—plowed early and the fallow kept free from weeds—will not respond to the use of commercial fertilizers. In this experiment, no significant increase in the yield of wheat was obtained from the application of sodium nitrate, ammonium sulfate, superphosphate or sulfur.

Tillage experiments. The tillage experiments with winter wheat, results of which were published in Oregon Station Bulletin 190 and United States Department of Agriculture Bulletin 1173, have been continued. Following is a summary of some of the results to date:

	Seventeen-year average acre yield of winter wheat after fallow
	bushels
Plowed April 1	28.2
Plowed May 1	27.0
Plowed June 1	22.9
Plowed early in fall	26.3
Plowed late in fall	25.1

In the depth-of-plowing experiment, which has also been in progress for seventeen years, the yield of winter wheat after fallow plowed 10 inches deep was only .3 bushel more than after fallow plowed 5 inches deep.

In an experiment to determine the value of disking as a substitute for plowing, the average yields for a four-year period were as follows:

Winter wheat	
Disked fallow	19.2
Plowed fallow	18.4
Spring wheat	
Disked fallow	18.3
Plowed fallow	19.7

These results suggest the possibility of the substitution of disking for plowing on many of the lighter soil types of the Columbia Basin. As plowing is a much more expensive tillage operation, this substitution will substantially reduce production costs in wheat raising.

Crop-rotation experiments. The crop-rotation experiments, results of which have been published in detail in Oregon Station Bulletin 209, have been continued without interruption. In experimenting with various crops during the past eighteen years, the following rotations have produced higher average yields than the standard method of raising winter wheat after fallow: (1) spring wheat—peas, (2) spring wheat—corn—barley, (3) spring wheat—barley—corn, (4) spring wheat—barley—manured fallow—corn, (5) spring oats—barley—peas turned under—corn, (6) spring barley—spring barley—fallow.

PENDLETON FIELD STATION, PENDLETON

An enlargement of the dry-farm crop-rotation work contemplated in the act passed by the 1927 Legislature (H. B. No. 590) was made possible by securing Federal Cooperation through the Office of Dry Land Agriculture of the Bureau of Plant Industry. In accordance with a memorandum of understanding with this Bureau and the Oregon Agricultural Experiment Station, effected since December 1, 1928, approximately $9,000 annually will be allotted by the Federal government for crop rotation, tillage, and fertilizer studies on the dry lands of the Columbia Basin of Oregon. A tract of 160 acres of suitable land to conduct these experiments was provided by the county of Umatilla on which the Pendleton Field Station was established. Umatilla county furnishes the land and the Department of Agriculture and the State of Oregon, through the Office of Dry Land Agriculture and the Oregon Agricultural Experiment Station respectively, cooperate in maintaining and conducting the investigations. The Station is located on productive Umatilla county wheat land about eleven miles northeast of the city of Pendleton.

The Station farm was all in fallow in 1928 and was uniformly cropped to winter wheat in 1929, with the exception of a few acres used for grain varietal trials. The portion of the field used for crop-rotation and tillage experiments was harvested in one-tenth-acre units to obtain information on soil variability in advance of starting the experimental work.

A comprehensive series of the crop-rotation, tillage, and fertilizer experiments was started in the fall of 1929, mainly for the purpose of (1) ascertaining the most practical and economical methods of maintaining and increasing soil fertility of wheat lands that have been continuously

cropped to grain for about half a century, (2) studying effect on crop yield and soil fertility of various cropping systems, with and without fallow, and (3) determining the effect on yield and quality of wheat of varying tillage methods in connection with the growing of wheat after fallow.

In addition to these experiments, varietal testing work with cereals, legumes, and other crops will be conducted.

Largely from receipts from the sale of the 1929 crop, a superintendent's residence and an implement shed have been constructed. A drilled well, 285 feet deep, which provides ample water for household use, has been dug. An office and laboratory building, a storage room for seed, and a small barn are urgently needed and will be erected as soon as funds are available.

SOUTHERN OREGON BRANCH STATION, TALENT

The work of this Station is chiefly devoted to tree fruits, and most of the experiments require years for completion. Hence much of this report is in the nature of a progress report of work which has been under way for many years, and is devoted in part to the same subjects discussed in the previous report.

Pear stocks. Results during the past two years have again given strong evidence that the Chinese stock, *P. ussuriensis,* and the Japanese stock, *P. serotina,* are not well adapted to our very heavy and shallow types of soil. On such soils these stocks produce much smaller trees than the old standard French stock. On deep, mellow, and well-drained soils, however, trees on these stocks are fully equal in size and productiveness to those on French stock, at least up to ten years of age. Since most of our pear soils are of the very heavy types, these two stocks can not be recommended.

The trees on *P. calleryana* and *P. betulaefolia* stocks are as large in all cases, and in one plot larger, at ten years of age than those on the French stock. It is well known that trees on some stocks do not show the same relative differences as the trees reach maturity, and in some instances trees which are superior on certain stocks in earlier years become inferior at maturity. Hence this comparative test must be continued for many years longer before final conclusions can be reached.

This Station has isolated the most vigorous and desirable strains of French, *P. calleryana* and *P. betulaefolia,* and is making these available for commercial propagation.

Blight resistance. Pear blight is more destructive in the Rogue River Valley than all other pear diseases combined. For this reason a large part of the work of this Station is devoted to better methods of control.

The most serious phase of this disease is root blight. This is the source of much "hold-over" blight, is difficult to detect until well advanced, and the most difficult and expensive to eradicate. The most promising method of combating this disease is to propagate trees on resistant root stocks.

(a) *Resistant root stocks.* During the past ten years thousands of seedlings of each of the five most promising species of pear root stocks have been inoculated with blight and tested for resistance. In all of these species

most of the seedlings blight readily. In each species, however, some highly resistant individuals have been found. The second important step is to determine whether these will reproduce true to type from seed. The second generation of some of these types has been tested during the past two years. Very fortunately in the three species so far tested certain resistant types, or individuals, have been found which transmit this high degree of resistance to their seedlings.

(b) *Body stocks.* The work of isolating resistant and desirable trunk or body stocks has been continued during the past two years. One of the most promising of these stocks during the earlier stages of this work is the Old Home. At the Station this has given good results. In the lowest part of the Valley, along Rogue River, this type has proved susceptible to an unidentified canker disease. During the past two years it has been shown that this disease can be controlled by one application of bordeaux spray every fall, just before the winter rains begin.

Another promising body stock is the Variolosa. This is just as resistant as the Old Home and so far has also proved resistant to the canker disease.

Other promising stocks are now being tested for this purpose.

(c) *Bordeaux spray for blight.* The experiment with bordeaux spray for blight has been continued during the past two seasons. The results during this period have been in conformity with those obtained during the previous five years. Again striking benefits have been obtained from the use of this spray in reducing the number of blight infections.

As a result of these experiments spraying with bordeaux for blight has now become a well established practice in some of the commercial orchards of the Valley. The beneficial results in these orchards have been even more pronounced than in the Station orchard. This is due to the large blocks sprayed in these commercial orchards, while at the Experiment Station the sprayed plots are small and alternate with unsprayed check plots, thus permitting reinfection of the sprayed plots.

During the spring of 1930 this Station experienced the worst blight epidemic of its history. The disease swept through the variety orchard with very destructive results. This has proved a blessing in disguise. It has presented an excellent opportunity to study the relative resistance and susceptibility of the many varieties at the Station. Many varieties were destroyed, others badly damaged, some proved highly resistant, and a few immune. These resistant varieties will be valuable for further work with stocks and breeding work.

Time of picking and storage of pears. The project on the time of picking and cold storage of pears has been conducted for the past five years in cooperation with the Central Station at Corvallis. The results during the past two years have been in harmony with those obtained during the previous three years. With the use of the pressure tester the proper time for picking the commercial varieties of pears has been definitely established. The practice has been placed on a reliable and scientific basis, and all the pears in this Valley are now picked at the pressures established by these experiments.

This work has also determined the storage life of commercial varieties of pears, and has shown that heavy losses result when the pears

are held beyond the correct picking period. The commercial practice is now largely based on these results.

Soil type and pear quality. Extensive work with pears from various soil types has shown that soil type markedly influences the quality of pears. Bosc pears develop the best quality on the heavy upland adobe and clay soils, and are inferior when grown on the lighter creek-bottom soils. This is very fortunate as the heavy soils predominate here and the vast majority of Bosc orchards have been planted on these types.

The Comice develops its best quality on the lighter types of soil, and poorest quality on the very heavy soils. This is also fortunate since this variety is also far more productive on these lighter soils.

The other commercial varieties of pears grown show no such striking soil preferences and develop good quality on the various soils. The Winter Nelis, however, is more productive and the fruit is larger on the most fertile soil types.

Little leaf of pears. This Station in cooperation with the Chemistry department at the Central Station is conducting experiments to determine the cause of the Little Leaf of pears, and attempting to find a remedy for this disease. This is a physiological disease caused by some abnormal soil condition. Up to the present time no chemical differences have been found in the soils under affected and unaffected trees. Various chemicals are being applied with the hope that at least one of these will prove a corrective.

Anjou pollination work. The Anjou pear is an erratic and often a shy bearer. This has very generally been attributed to lack of proper pollination. Work conducted at this Station has shown that numerous varieties will pollinate the Anjou in Southern Oregon. Of the varieties grown here the Bartlett, Howell, and Fall Butter have proved good pollinizers for the Anjou. Bosc, Comice, and Winter Nelis bloom later than the Anjou in this Valley, hence are not effective pollenizers for this variety.

Propagation experiments. The Station is vitally interested in propagating the resistant root stocks true to type. The only known method of getting the plants absolutely uniform and true to type is by vegetative propagation. Many plants can be thus propagated from branch cuttings, but this method has failed with pears. Very young pear trees can be successfully propagated from root cuttings. This method usually fails with trees at least six years old, and trees are not ready for propagation until they have been tested for at least that length of time. Extensive experiments are now in progress to develop methods of propagating successfully such thoroughly tested trees at this Station. A new method is now being developed which appears very promising.

During the past ten years poor stands have often been obtained from pear seeds grown for root stocks at this Station. During the past two years the reason for such poor stands has been ascertained and a successful method of planting developed.

Youngberry. In the hot dry summer climate of Southern Oregon many varieties of cane fruits have proved a failure. Even the Loganberry is not very productive. Among all the cane fruits thus far tested at the Station

the Youngberry appears the most promising. During the past two years this variety has proved vigorous, healthy, an early and productive bearer, and the fruit is of excellent quality. It is a cross between the Loganberry and the Southern Dewberry.

Jerusalem artichoke. During the season of 1929 this Station conducted an extensive experiment with Jerusalem Artichokes, using the French Improved variety. This test showed that this plant grows remarkably well on the creek-bottom soils. The yields ranged from fifteen to twenty tons per acre on the different types of soil. The sugar content is remarkably high, yielding 23 percent. On suitable soils this should prove a valuable crop for either levulose sugar production or for hog feed.

Codling-moth investigations. Codling-moth control investigations on apples are being continued. Combinations of oil and arsenate of lead gave better control than arsenate of lead alone. All oils gave more or less calyx injury to Newtown apples, which in some instances was not of commercial importance. The use of oil with arsenate of lead did not prevent the removal of arsenical residue to below .01 grain per pound, even when light weight oils were used as late as August 16. Field tests with light weight oils gave from 96 percent to 100 percent kill of eggs already laid, when used at dilutions as low as one gallon of the emulsion per 100, but had no effect on eggs laid on oil-sprayed trees the same and the following nights. During the present season oil is being combined with arsenate of lead in two applications only on Newtown apples—one at the peak of first-brood egg-laying and one for the peak of second brood. Only light-weight oils are being used. A large series of commercial and home-made oil emulsions are being tested from a standpoint of injury.

Codling-moth activities in the Rogue River Valley differ from those in other parts of the state; therefore spray recommendations are based on the moth catch in bait pans. In the past, growers have been advised to spray as much as two weeks later at higher elevations than at lower ones. Bait-pan records for different parts of the Valley during 1929, and so far this season, have shown that there is no important difference in time of egg-laying in the various localities. This apparently is due to the fact that temperatures during the day are high enough to cause the larvae to change to the adult moths, long before evening temperatures are high enough for egg-laying. When suitable evening temperatures do occur, moths are out all over the Valley.

Red-spider investigation. Because of the importance of this pest in pear orchards, investigations are being continued. D'Anjou and Bosc varieties are the most susceptible to injury. The time at which the mites leave the weeds for the pear trees varies considerably from year to year. As a rule, they are migrating during the early part of June. Two applications of a medium weight oil should keep them in check. One application may be combined with the last cover spray for first-brood of codling-moth, and the other one two weeks later.

San Jose scale investigations. Experiments for the control of the San Jose scale are being continued both on apples and pears. Lime-sulfur, at the rate of 12 gallons in 100 gave the best control, while oils came next, with variable control. Dry lime-sulfur gave only slightly better control

than half strength liquid lime-sulfur. Summer oil sprays for scale are of very great benefit, where the dormant spray has been omitted.

Injury of dormant oils to Winter Nelis pears. Experiments carried on over a period of years indicate that it is not advisable to spray Winter Nelis pears with dormant oils. This variety is very susceptible to injury from these oils, and many fruit and leaf buds may be killed and the growth of lateral leaf buds retarded.

EASTERN OREGON BRANCH STATION, UNION

LIVESTOCK

Growing and wintering beef cows. A growing test for beef heifers has been carried on for the past six years, in which heifer calves were taken at weaning time and wintered on such rations as full and light feeds of alfalfa hay, medium feeds of alfalfa hay and silage, alfalfa hay and rolled barley, as well as alfalfa hay and straw. Each of the one hundred calves had an identification number, and individual records were kept throughout the entire test. It is keenly regretted that owing to excessive losses on the open range during the grazing season, as well as the ravages of a recent outbreak of contagious abortion, the findings are not as complete as were hoped for. Some of the noticeable results of the test are as follows:

The cows that had been wintered on a half feed of alfalfa hay throughout the test had an average weight of 1,090 pounds; those receiving a full feed of straw and 7 pounds of alfalfa hay were 56 pounds heavier, those on hay and silage 173 pounds, those on a full feed of hay 204 pounds, and those on hay and grain 364 pounds heavier than those that had received the half ration of alfalfa hay. These differences in weights of the cattle in the various lots are not so marked at the close of the grazing period in the fall, which is due to the fact that the thinner cattle when going on the range make more rapid gains than those that are carrying considerable flesh.

In the better-fed lots, the growth and development of heifers producing calves when two years of age are not materially different from those that did not bring calves until three years of age. In the scant-fed lots, however, the difference in weight was decidedly in favor of those that did not produce calves until three years of age.

There is likewise a 3-pound difference in birth weight in favor of calves from cows in the better-fed lots over those from cows that had been wintered on the lighter rations.

In general the cows that were bred to commence calving when two years of age were the most profitable.

The winter feeding tests of 1929 demonstrated that matured cows going into the feed yards in fairly good condition can be carried through the winter feeding period of 120 days on rations of straw supplemented with either a pound of cottonseed cake, a pound of rolled barley, or 8 pounds of alfalfa hay. One lot of cows was wintered on straw alone with fairly good results. These are all submaintenance rations and are recommended only in cases of emergency. A limited ration of alfalfa hay is doubtless the most practical and profitable under most conditions.

Baby beef. During the 1928 feeding period the calves that had received ground corn in connection with their chopped alfalfa hay, and likewise those that had a grain mixture, made an average daily gain of 2.13 pounds and 2.16 pounds per head respectively. Those on rolled wheat made an average daily gain of 1.95 pounds, and those on rolled barley 1.89 pounds. The lot that was given long hay and rolled barley made an average daily gain of 1.91 pounds. The gain was not so large as in the case of some of the others, yet owing to the difference in feed costs the financial statement shows a decided balance in favor of this ration.

The baby-beef feeding experiments for 1929, in which both ground and chopped alfalfa hay were fed in comparison with long hay, gave results slightly in favor of the chopped hay.

The cattle receiving ground alfalfa hay and grain mixture produced the greatest gains, but owing to the increased feed cost they gave a net return of $2.77 per head less than that for the chopped hay ration.

There is no appreciable difference in the gains made by steers and open heifers; if any, the difference is slightly in favor of the former.

Farm flock management. In the winter care of ewes in which rations of alfalfa hay supplemented with either grain or silage were used there was but very little difference in the gains made by the various lots. Likewise, in the birth weights of lambs, there was no appreciable difference that could be attributed to different feed rations. There was a slight difference, however, in wool production in favor of the lot receiving silage in the ration.

The difference in the average weight of lambs at weaning time, if any, is in favor of the alfalfa hay ration. In fact this ration has proved to be one of the most practical that has been tried thus far.

In the 1929 tests, coarse and fine alfalfa hay was fed in the form of ground, chopped, and long hay with ground hay producing the largest gains, chopped hay second, and long hay third. Other lots of ewes were given rations excessively high in protein in order to determine their effect, if any, on the general health of the animal under different methods of management where some were allowed to exercise and others were not. Some lots received a ration of beets in connection with their alfalfa hay while others were provided with mineral supplements.

Growing ewe lambs. In the test during 1928 all lots made fairly satisfactory gains. The lambs receiving chopped alfalfa and ½ pound of barley made the best growth and were 15 pounds heavier at the close of the 100-day feeding period than those that had been fed on a ration of long alfalfa hay without grain.

The ration where a portion of the grain was replaced by a like amount of molasses did not produce as large a gain as similar rations without molasses.

The 1929 tests in which ground, chopped and long alfalfa hay was fed in addition to a daily ration of ¼ pound of barley for 120 days produced daily gains of .33 pound, .22 pound, and .17 pound respectively.

Swine management. In the feeding experiments conducted during 1929, brood sows that had been carried through the winter on a daily ration of 2½ pounds of a grain mixture containing equal parts of rolled barley and

mill-run and provided with leafy alfalfa hay fed in a rack, produced better gains than the ration of either ground or chopped alfalfa with like amounts of grain mixture. In previous tests, however, excellent results have been obtained with a ration consisting of a mixture of chopped alfalfa and rolled barley, equal parts being given in quantities that the sows will clean up readily. Especially is this true where a number of sows are fed together in a group. The bulkiness of the mixture prevents the more greedy individuals from getting more than their allowance as is sometimes the case when fed on more concentrated rations.

Some progress has been made in determining factors that tend to influence the size of litters. Records have been kept covering results obtained from flushing and non-flushing of both thin and fleshy sows. The results thus far seem to warrant the conclusion that a sow thin in flesh but thriving at the time of mating will bring a larger litter than one carrying an excessive amount of flesh. Likewise individuals that are allowed plenty of exercise during the gestation period as a rule bring forth stronger litters than those confined in small inclosures without exercise.

Weather conditions in Eastern Oregon are often quite cold at farrowing time during the early spring. The little pigs huddle close to their mothers in order to keep warm and are often crushed. The use of a poultry brooder stove or electric heater at this time has given excellent results. The stove or heater, of course, is protected to prevent the sows from coming in contact with it, yet allowing the little pigs to congregate in the warmth under the hover and thus keeping them away from their mother, greatly lessening the danger of their being trampled upon and crushed.

Fattening pigs. In comparing the relative value of various grains for finishing rather growthy shoats under dry-lot conditions, cracked peas were found to produce a daily gain of 1.92 pounds per head, rolled wheat 1.88 pounds, and rolled barley 1.72 pounds.

Dairying. Unfortunately much of the breeding work in connection with the dairy herd at the Station has been seriously handicapped owing to the ravages of contagious abortion. An outstanding lot of young cows had been developed from the progeny of a meritorious sire. Many of them had won signal honors in the cow-testing association.

From records obtained at the Experiment Station covering machine and hand milking it seems that the average dairyman will care for thirty cows under machine milking about as easily as he will care for fifteen cows when milking by hand.

Poultry. Though poultry is comparatively a new unit at the Experiment Station, it gives promise of becoming one of the most popular. A great deal of interest is manifested in both flock and building equipment. The open-type laying house has given very good results; however, for Eastern Oregon conditions a revised and more inclosed plan is recommended.

Records are kept covering poultry management in general as well as feeds consumed and poultry products produced.

Electric lights are used during the winter months. These apparently increase egg production at a time when prices are usually the highest.

CROPS

Forage crops. Keen interest is taken in different forage and pasture crops, which is doubtless due to an increase in dairy and farm flock activities.

Grazing results obtained from permanent pasture plots at the Experiment Station are in favor of a grass mixture in which orchard-grass is the chief constituent.

Yellow sweet clover with fall wheat seeded in the spring has given excellent pasturage results.

During the past few years Ladino clover has not proved very satisfactory at the Station. Later plantings on very wet soil, however, give promise of real value for pasturage purposes.

The Experiment Station has long advocated the growing of peas and barley or peas and oats for silage purposes, especially in localities where the frost hazard prevents the successful production of corn. Many of our dairymen are now using this crop in preference to corn, owing to the comparatively low cost of production and beneficial effect on the soil.

Truck and root crops. Varietal plantings of stock beets and carrots are maintained in order to furnish information relative to succulent feeds, which especially applies to dairymen who are not in a position to feed silage. The Giant Red Eckendorf beet and the White Belgian carrot are the two heaviest yielders.

The Netted Gem potato is the most popular commercial variety of potato for this section.

Cereals. Cereal production is still one of the chief factors in the agricultural activities throughout this section, hence rather extensive nursery and varietal trials with wheat, oats, barley, peas, and flax are grown at the Experiment Station with an earnest endeavor to ascertain the more desirable varieties.

Owing to the low price of wheat some interest is being manifested in flax. Damont, Reserve, and North Dakota Resistant No. 52 have a five-year average of a little better than 17 bushels of seed per acre.

Cereal breeding and selection. There is still a keen demand among wheat growers for an improved, winter-hardy variety with a short stiff straw. The Station has under cultivation at present a number of varieties produced at the Moro and other stations, as well as some of its own hybrids and pure-line selections, in hope of obtaining a variety possessing these desirable characteristics.

Of the later productions resulting from the plant-breeding experiments at the Station the Union Beardless barley is possibly the most outstanding. This is a very desirable beardless variety with good yielding qualities for either grain, hay, or silage purposes.

Crop rotations. A summary covering seven years' results shows the rotation winter wheat—peas—potatoes to be decidedly the most profitable. While this rotation may not be practical under big farming operations, it will doubtless fit in excellently with the smaller diversified units. Not only does the rotation system keep the land free from weeds and improve the

physical condition of the soil, but it likewise produces 8.38 bushels more wheat per acre than its nearest competitor, winter wheat after fallow.

Fertilizer experiments. The application of 200 pounds of superphosphate per acre every third year has increased the winter wheat yield 7.67 bushels per acre. This at present market prices gives a net increase over untreated plots of $3.10 per acre.

The application of both nitrogen and phosphorus in cases of such silage crops as peas and barley and corn has likewise given good results.

Miscellaneous investigations. For the past eleven years the Experiment Station has made measurements of hay stacks and recorded yields calculated according to Quarter Master, Frye-Bruhm, and Government rules in comparison with actual weights. These data are being used by the Bureau of Agricultural Economics, United States Department of Agriculture, in formulating more definite rules governing stack measurements. Thus far the Quarter Master rule has proved to be the most practical.

Weed control. Plots of quack-grass, Canadian thistle and morning-glory were sprayed with sodium chlorate. The green portion of the plants was apparently killed soon after the application. The following spring a few of the weeds appeared, necessitating a second spraying. The killing effect on the soil is still quite evident after a period of four years.

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